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Evaluation Of Ozone Trends In Southern Doña Ana County, New Mexico Thru Wind Rose Analysis And Use Of NOAA HYSPLIT Model

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Dedication

Dedicated to my parents, Jose Amadeo and Consuelo Sisneros. I will always be grateful for your love and support but especially for the example you were.

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By

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THESIS

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Abstract

The objective of this study was to determine whether increasing ozone concentrations in 2012 and 2013 at the Santa Teresa air quality monitor in Doña Ana County, New Mexico were due to a local point source impacting this monitor only or part of a regional phenomenon that affects all the monitors within the Paso del Norte Region. In addition, the study focused on identifying local and regional/long-range source areas contributing transport ozone to the study area (southern Doña Ana County).

The study showed that increasing ozone levels were not unique to the Santa Teresa monitor due to the fact that all the monitors showed similar ozone peaks on high ozone days. This indicated ozone increases measured at the stations are a regional phenomenon experienced by all the stations. In addition, no point source was located upwind of the Santa Teresa monitor that showed a facility was contributing to the ozone concentration measured for 2012 and 2013.

Wind rose plots from 2006 to 2013 for the air quality monitors (6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa and C12-UTEP) for high ozone days (> 0.06 ppm) showed that the prevailing winds were from the east-southeast (ESE) direction, followed by an east (E) or southeast (SE) direction, which indicated local transport ozone is from the El Paso-Ciudad Juarez area approximately 20 percent to 50 percent of the time, depending on the year and monitor. In addition, the poorest air quality, ozone concentrations greater than 75 ppb, for these same years were observed when prevailing winds also arrived from an ESE, SE or E direction.

The HSYPLIT model utilized to develop a 72-hour trajectory cluster analysis for high ozone days for 2006, 2012 and 2013 showed that transport ozone arrived to the study area from a number of geographic regions. These regions were the Lower Rio Grande Valley and northern Mexican Border States (southeast); Baja California and Sonora (west), southern California and Southern Arizona (west), and central-northeast Texas (Dallas, Austin and San Antonio) and Oklahoma.

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Chapter 1: Introduction

Doña Ana County, New Mexico is located in the central, southern part of the state, where air quality monitoring for criteria pollutants within the county has existed since the 1970s with continuous ozone monitoring beginning in 1984 in La Union and later expanding further south, to the communities of Sunland Park and Santa Teresa (NMED, 2007). Currently, there are five air monitoring stations in southern Doña Ana County that monitor ozone, in which the monitoring station, 6ZM-Desert View, located approximately 1-mile north of the U.S.-Mexico border in the south-central part of the county, has historically been the monitor of concern for local environmental authorities. This monitor has consistently indicated the higher ozone concentrations and a higher design value for a monitor in that part of the county. The design value at a monitor is based on a 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration. The design value for a county is based on the monitor with the highest design value for a calendar year. For this reason, this monitor has also been the representative monitor for the ozone design value for Doña Ana County. When a county design value exceeds the 8-hour ozone standard set at 0.075 parts per million (ppm), the county is in violation of that standard.

Beginning 2013, the 6ZN-Santa Teresa air quality monitor located just north of the Santa Teresa Port of Entry (POE) and approximately 6 miles west of the 6ZM-Desert View monitor began to be of greater concern for state environmental authorities. To date Doña Ana County has been in attainment of the 8-hour ozone standard. However, the 2012 and 2013 ozone concentration levels measured at this monitor have been such that for regulatory purposes, if the 2014 ozone levels are high enough, this could potentially place the county at risk of being in violation of compliance with the 8-hour ozone standard.

1.1 Objective

The objective of this study was to understand the long term ozone trends in southern Doña Ana County (the study area), by utilizing historical meteorological and air quality data from January 2006 through September 2013 to determine whether increasing ozone concentrations are unique to the area

near the 6ZN-Santa Teresa air quality monitor or if this is a problem that the Paso del Norte (PdN) Region as a whole experiences. In addition, the study investigated potential local source areas, as well as regional and/or long-range that may be contributing to ozone pollution in the study area. A wind rose analysis of several monitors in Doña Ana County, New Mexico and one monitor in El Paso, Texas was utilized for the 2006 to 2013 ozone seasons to identify surface wind speeds and prevailing wind direction for high ozone days. Wind roses for several stations were developed as an initial screening tool to determine the frequency of wind direction and wind speed distribution at these monitors, as air quality is often correlated with the dominant transport of direction of the wind. Second, wind roses for several monitoring stations were used as a way to "triangulate" transport ozone from a local source to the study area. A pollution rose analysis was also conducted to determine the frequency of direction in relation to ozone concentrations arriving at the monitoring stations.

Lastly, the NOAA HYSPLIT model was utilized to identify potential source origins or regions of long-range ozone transport (including ozone precursors) during high ozone days through the use of backward trajectory analysis. This study will aid local stakeholders, gain a better understanding of pollution transport influencing the region, which is a key step for better planning and implementing appropriate and effective control strategies appropriate to the region.

1.2 Summary of Thesis Content

Chapter 2 provides background information regarding the study area and review of the most current emission inventories conducted for the Paso del Norte Region (west Texas, southern New Mexico, and northern Chihuahua region). The chapter will briefly introduce the various types of local sources that emit nitrogen oxides (NOx) and volatile organ carbon (VOC) emissions, which contribute to the generation of ozone pollution.

Chapter 3 provides a description of the methodology used to identify local and long range transport of air pollution to the study area. Wind and ozone pollution roses, were generated for several monitors within the study area, for high ozone days during the 2006 – 2013 ozone seasons, to help identify local sources contributing transport ozone to the study area. The wind and ozone pollution roses generated identify the frequency distribution of wind direction in relation to wind speed and ozone

concentrations that the air quality monitors experience. NOAA HYSPLIT model was utilized to conduct backward trajectory analysis to determine regional/long-range transport sources contributing to the ozone pollution in the study area.

Chapter 4 discusses general background information regarding the current New Mexico Environment Department's air quality monitoring network. Informational time series graphs regarding annual ozone trends, between 2006 through 2013 are presented.

Chapter 5 focuses on presenting a wind and ozone pollution rose analysis to demonstrate the frequency of distribution of wind direction in relation to wind speed and ozone concentration arriving at the stations: 6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa and C12-UTEP, for the ozone season (May through September) for years 2006 through 2013. Wind Rose and Ozone Pollution Rose analysis was conducted on high ozone days which are defined as days with an 8-hour daily maximum ozone concentration greater than 0.06 ppm. For wind and pollution roses, the 8-hour period between 10 A.M. to 6 P.M. was the only time period utilized, as this demonstrates or captures the time of the day when ozone concentration levels reach their peak.

Chapter 6 presents a 72-hour trajectory cluster analysis for years 2006, 2012 and 2013 for high ozone days. The National Oceanographic Atmospheric Association (NOAA) HYSPLIT model was utilized for the backward trajectory analysis in order to determine possible long range transport of pollutants to the region for high ozone days. In addition, further analysis of the top three days in 2013 with the highest daily maximum 8-hour average ozone concentrations for the Santa Teresa monitor is presented to understand the transport of pollutant for the highest ozone days during the 2013 ozone season.

Chapter 7 presents discussions and conclusions.

Chapter 2: Background & Literature Research

2.1 Ozone Formation

Ozone (O_3) can be considered either beneficial or harmful. In the upper atmosphere, ozone provides a protective layer from ultraviolet radiation, whereas in the lower atmosphere, the troposphere, ozone can be harmful to both public health and the environment. Ozone is considered a secondary pollutant formed by the photochemical reaction of its precursors, nitrogen oxides (NOx) and volatile organic compounds (VOCs), with ultraviolet radiation. The control of ozone is difficult because it is a secondary pollutant. Unlike primary pollutants (i.e. NOx, VOC, Carbon Monoxide (CO) and Sulfur Oxides (SOx)) ozone does not respond proportionally to the reduction of its precursors (Lu et al., 2008).

Typically higher concentration of ozone occurs during the summer months in an environment where there is a significant concentration of NOx and VOCs present in combination with stagnant atmosphere conditions (calm to low winds) and intense solar radiation. The production of ozone and level of ozone concentration in an area can be complex, as it can be influenced by a number of factors beyond human control such meteorological processes (i.e. atmospheric mixing, temperature, wind speed and direction, relative humidity, etc.) which can either increase or decrease the production of ozone (Gray & Finster, 1999). Wind speeds can determine how quickly ozone is transported out of an area or how it is dispersed. Aloft winds can also play a role in ozone concentrations by influencing the degree and the rate of mechanical or turbulent mixing in the boundary layer (Gray & Finster, 1999).

In a 1996 Paso del Norte (PdN) Ozone study conducted by Sonoma Technology, Inc. and the Environmental Protection Agency (EPA) Region 6, higher concentrations of ozone were measured when surface wind speeds were low, the mixing height of the convective boundary layer (CBL) was shallow, and the growth rate of the CBL was slow. The shallower mixing height confined ozone precursors to a smaller mixing volume of the air basin, giving rise to increasing ozone formation as the day progressed. However, when similar conditions occurred (i.e. shallow mixing layer and slow mixing growth rate of CBL), but with moderate to stronger surface winds, ozone concentrations were less concentrated at a particular site due to the fact that the ozone precursors were dispersed horizontally, distributing the ozone levels throughout the region rather than being concentrated at one site (MacDoñald et al., 2001).

Topography/geography can also play a role in the production of ozone. The Paso del Norte Region has a unique topography, in which the geographic features within and surrounding the air basin form an almost “bowl” shape, where pollutants can become trapped and contribute to an increase in air pollution at various times throughout the year. The Franklin mountains (Figure 2-1), which run north to south – dividing the City of El Paso into an east and west region; the Sierra Madre Juarez mountains, located west of Ciudad Juarez; and the Rio Grande Valley that defines the border between El Paso and Juarez, as well as El Paso and Doña Ana County; all these topographic features have a strong influence on the concentration and transport of pollutants within the air basin, as well as the direction of local surface winds during the ozone season (MacDoñald et al., 2001).

Figure 2-1: Map of Geographic Area of Paso del Norte

Other factors that drive ozone production in an area are the photochemical reactions between ozone precursors emitted from local sources (either natural or anthropogenic). Transport ozone and/or

precursors from regional, long-range or global sources (Heuss, Kahlbaum, & Wolff, 2003) and stratospheric ozone migration to the lower troposphere, can also contribute to the increase in ozone concentrations in the atmosphere.

A 2009 study, published by Arizona State University and Arizona Department of Environmental Quality (Shi, Fernando, & Yang, 2009) found that high ozone concentrations (during an ozone episode in El Paso on June 2006) are mainly driven by the processes of vertical diffusion, vertical advection and photochemical ozone production. However, it was the photochemical processes that are the major source of ozone formation in the region. After ozone peaks, it begins to be “removed by vertical advection and titrated by chemistry at night” (Shi, Fernando, & Yang, 2009). The study also showed that ozone is transported into the area at night and early morning hours and driven out during the day. Backward trajectory analysis conducted showed that ozone was transported from northern Texas and Oklahoma regions.

A typical summer day in the Paso del Norte region (west Texas, southern New Mexico, and northern Chihuahua region) begins with light north-westerly winds into the region caused by the drainage flows from the Franklin and Juarez mountains into the Rio Grande Valley. As the day progresses and the sun warms the eastern and southern portions of these mountain areas, the winds take a reverse direction to flow from the south and east. This heating of the surface also causes the boundary layer to begin to deepen, which in turn allows atmospheric mixing between surface and aloft layers (MacDoñald et al., 2001). Ozone concentration usually peaks between noon to 2 p.m. in the Paso del Norte Region (MacDoñald et al., 2001; Li et al., 2011).

2.2 VOC and NOx Ratios

In order to understand what appropriate emission control strategies may work for the region, it is important to understand the relationship between VOCs and NOx in relation to ozone formation. The amount at which ozone is formed can be limited by either VOCs or NOx present in the environment. When an area has a relative high VOC/NOx ratio, meaning VOCs are present in considerably higher quantities relative to NOx, the amount of ozone formed is determined by the concentration of NOx present, and is known as “NOx-limited” (Figure 2-2). In this situation, decreasing NOx sources reduces

the concentration of ozone. The opposite occurs when there is a low VOC/NOx ratio, where NOx is present at higher concentrations than VOC concentrations. In this case, VOCs will inhibit the formation of ozone; this situation is known as "VOC-limited". VOC-limited environments are typically associated with larger urban centers where there is a higher production of NOx emissions from mobile and/or industrial processes. One thing to note in this type of regime, while reducing VOC emissions can lead to a reduction in ozone, reducing NOx sources could actually increase ozone emission as well (Heuss et al., 2003). The latest Rider 8 Conceptual model (Li et al., 2011) along with previous studies have suggested that the Paso del Norte region is NOx-limited during the ozone season, but shifts to a VOC-limited environment during the winter and early spring months.

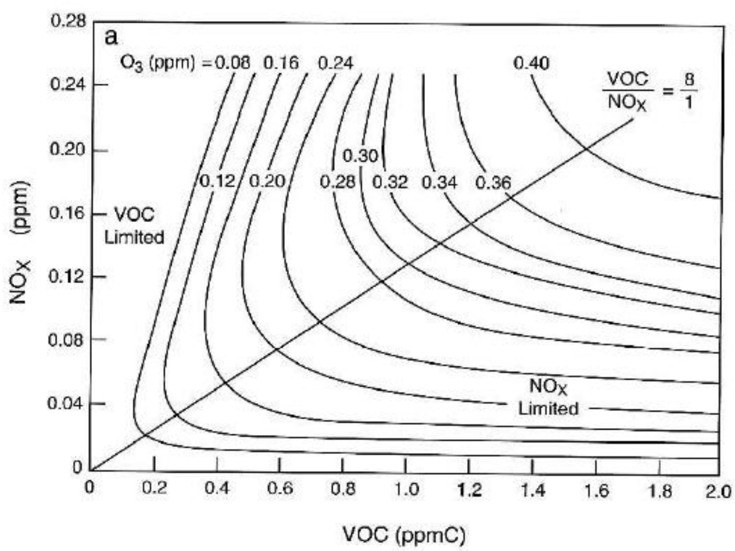


Figure 2-2: VOC and NOx Sensitivity (Finlayson-Pitts and Pitts, 1993)

2.3 Study Area: Southern Doña Ana County

Doña Ana County is located in the central, southern part of the State of New Mexico. According to the 2010 Census Bureau, the county population at the time was 209,233 persons, approximately 10% of the state's population. The county itself is approximately 3,808 square miles in area. The adjacent county boundaries consist of Sierra County to the north, Luna County to the west, Otero County to the east, El Paso County, Texas to the southeast and the Mexican state of Chihuahua to the south.

The area of interest for the purposes of this study includes several smaller communities located within the southern part of Doña Ana County: Santa Teresa, Sunland Park, Anthony, La Union and Chaparral (Figure 2-3).

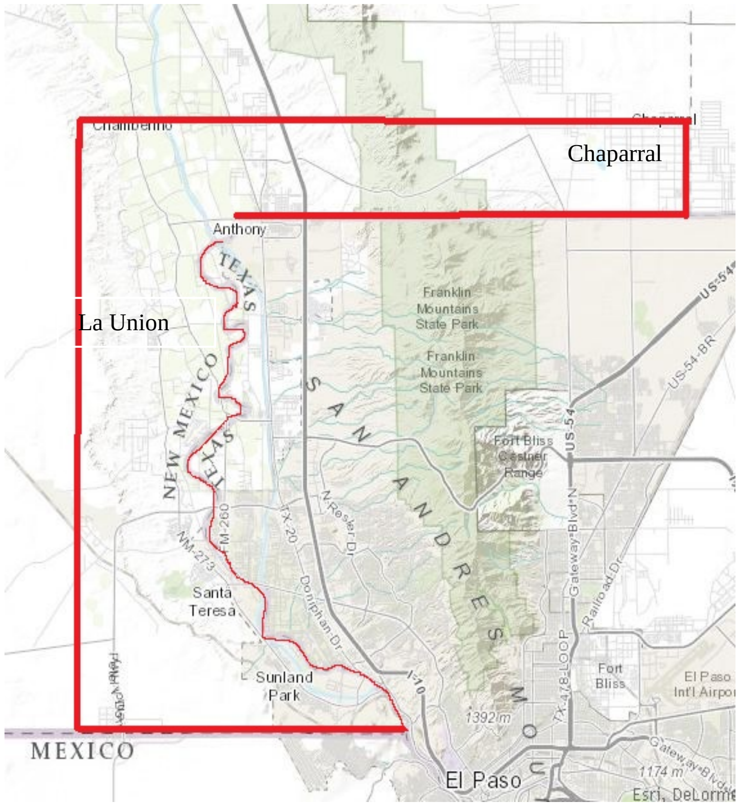


Figure 2-3: Approximate Boundaries of Southern Doña Ana County Area. (Source: Doña Ana County Geographic Information System Division, 2014)

The 2010 United States Census Bureau statistics showed that these five communities have a combined population of 43,461 people, almost 20% of the population of Doña Ana County, comprised of approximately 60 sq. miles of the total area for county. Major features within these Southern Doña Ana communities are residential property, commercial properties and industrial parks, an International Port of Entry (POE), water and wastewater treatment plants, commercial horse track and casino, agricultural fields, electric power plant, and a small airport.

2.4 Local Sources of Ozone Pre-cursors in the Paso del Norte Region

In the Paso del Norte region ozone precursors (VOCs and NOx) are produced through a number of anthropogenic (i.e. point, area, non-road, on-road) and natural (i.e. biogenic) sources. Specific

anthropogenic sources that produce both VOC and NOx emissions, include but are not limited to, the fuel combustion and evaporation associated with: 1) mobile sources (both on-road and off-road), 2) larger stationary sources such as the power electric plants and refinery, 3) smaller stationary sources such as gasoline dispensing or refueling stations, and 4) gas-boilers within certain facilities. Other sources within the Paso del Norte region that produce VOC emissions specifically, are municipal wastewater treatment plants, dry cleaners, automotive repair and paint body shops and pesticide applications for agriculture use. Biogenic sources (i.e. vegetation) also contribute to VOC emissions in the region.

2.4.1 Emission Inventory for Paso del Norte Region

The most recent emission inventory for El Paso County, Texas, Ciudad Juarez, Chihuahua and Sunland Park, New Mexico is presented in Table 2-1. Mobile sources is represented by both on-road and non-road sources in Table 2-1. Based on the latest emission inventories from these areas, the southern portion of Doña Ana County comprises approximately 3.5% of the total combined ozone pre-cursor emissions of these communities. Overall in the region, mobile sources are the major contributors to the production of NOx in the El Paso and Cd. Juarez areas. However, point sources within the Southern Doña Ana County region are the major contributors of NOx followed by mobile sources.

Table 2-1: Emission Inventory of Paso del Norte

	Sunland Park, New Mexico* (Tons per year)		El Paso County, Texas** (Tons per year)		Cd. Juarez, Chihuahua** (Tons per year)	
	NOx	VOC	NOx	VOC	NOx	VOC
Mobile	830	530	12,541	5,852	12,564	8,151
Area	30	194	1,240	9,513	1,080	24,895
Point	1,086	94	4,687	1,056	6,223	2,574
Biogenic	5.74	528	Not available	Not available	1,720	3,039

(*Emission data is based on 2002 baseline year inventory, *Ozone Maintenance Plan for the Sunland Park, New Mexico Nonattainment area*; ** Emission data based on 2008 Baseline Year Inventories prepared by Environmental Resource Group (ERG) and UT Austin for both Ciudad Juarez and TCEQ (Li et. al 2011))

The NMED emission inventory, which is based on a baseline year of 2002, categorized air emissions in Sunland Park into combustion (i.e. industrial, commercial, residential use of natural gas, oil, LPG and coal, open burning of agriculture, forestry and trash burning) and evaporative sources (i.e. solvent use, coat and paint operations, dry cleaning and pesticide use). Area NOx emissions were primarily comprised of combustion sources and were approximately 30 tons per year. Area VOC emissions from combustion and evaporative sources were approximately 37 tons per year and 157 tons per year, respectively. Mobile NOx emissions comprised of both on-road and non-road sources were 661 tons per year and 170 tons per year, respectively. Mobile VOC emissions of on-road and non-road sources were 464 tons per year and 66 tons per year, respectively.

2.5 Emission Sources within Santa Teresa and Sunland Park, New Mexico

2.5.1 Point Sources within Industrial Parks in Santa Teresa, New Mexico

Beginning in 2009, Santa Teresa, New Mexico and Jerónimo (part of the Municipality of Juarez), Chihuahua area experienced a tremendous increase of business growth and development. To get a better understanding of the growth and commercial development that the region experienced, the New

Mexico Border Industrial Association reported that the state of New Mexico's economy saw a 31% increase in trade from 2011 to 2012, with a trade revenue increase from approximately $464,454,999 to $617,609,684.

Two industrial parks, Verde Bi-National and Verde Logistics, located within Santa Teresa also experienced a significant increase in construction projects with companies flocking to this region to take advantage of state industry tax breaks and growing trade. In addition, existing businesses expanded their own facilities. It should be noted, many of these new or expanding businesses are more distribution warehouses versus manufacturing facilities where pollutants are emitted from manufacturing processes. In the short term, construction and businesses expansion activities can lead to an increase in NOx and VOC emissions, due to the increase in traffic from mobile sources (i.e. emissions from material delivery trucks and worker commuter trips to the construction site). In the long term, the increase in total number employees working at the industrial parks can also lead to an increase in NOx and VOC emissions due to the additional vehicles on the road.

The EPA's Envirofacts database was utilized to identify current facilities (Table 2-2) located within the two Santa Teresa Industrial Parks reporting VOC and NOx emissions. The database showed that the following facilities reported both NOx and VOC air emission to the AIRS/AFS (Air Facility System). "AFS contains compliance and permit data for stationary sources of air pollution (i.e. electric power plants, steel mills, factories, etc.) regulated by EPA, state and local air pollution agencies. The information in the database is used by state agencies to prepare State Implementation Plans (SIPs) and track the compliance status of point sources with various regulatory programs under the Clean Air Act." (EPA: www.epa.gov/enviro/facts/afs/index.html). It should be noted that the air emission data for these facilities is not available through the public database; therefore, no emission data is presented for these facilities with the exception of Title V permitted facilities, where emission data was identified in the most recent NMED emission inventory conducted.

The EPA Enviriofacts database identified seven facilities within these two industrial parks as reporting VOC and NOx emissions. Only one facility located within the industrial parks, FXI (formerly Foamex International Inc.), was identified as being a Title V Permitted facility. The most recent NMED

emission inventory (NMED AQB, 2007) identified, FXI, emitting approximately 11 Tons Per Year (TPY) of NOx and 64 TPY of VOC emissions. The FXI facility is located approximately 3 miles northwest of the Santa Teresa monitor.

In general, EPA may require a facility or a source to have Title V operating permit if: 1) It is considered a major source, that is, the source's emissions exceed certain thresholds such as more than 100 TPY of any criteria pollutant, 10 TPY for any single hazardous air pollutant (HAP) or 25 TPY for any combination of HAPs; 2) the source is subject to existing requirement such as New Source Performance Standards (NSPS) or National Emission Standards for Hazardous Air Pollutants (NESHAPS); or 3) if the source is located within an area that does not meet the criteria pollutant standards, in such case, sources in these areas would be subject to a Title V operating permit because the thresholds identified above are lower in these areas (EPA, 2014).

Table 2-2: List of Facilities Within Santa Teresa, NM and Sunland Park, NM Industrial Parks Reporting NOx and VOC Emissions (*Source: EPA Envirofacts Database, retrieved March 4, 2014*)

Facility	Address	Latitude	Longitude	City	Pollutant Reported	Notes
Celco - Santa Teresa	2690 AIRPORT ROAD	31.86555	-106.69325	Santa Teresa	VOC	
FXI (formerly FOAMEX)	2500 AIRPORT RD.	31.8606	-106.69025	Santa Teresa	VOC, NO2, others	Title V Permitted Facility
Georgia Pacific Corrugated - Vista Corrugated Paper Plant	17 KITTY HAWK BLVD	31.85762	-106.69106	Santa Teresa	VOC, NO2, others	
Johnson Plate And Tower - Santa Teresa Facility	7.6 MI NW OF SUNLAND PARK	31.8575	-106.70417	Sunland Park	VOC, NO2, others	
Nm Sun Tower Project	4 MI W OF SUNLAND PARK	31.85493	-106.67862	Santa Teresa	VOC, NO2, others	
Rogers Foam Corporation Nm Plant	2.5 MI NW OF SANTA TERESA	31.86986	-106.69929	Santa Teresa	VOC	
Sterigenics Us LLC	2400 AIRPORT RD.	31.85833	-106.6875	Santa Teresa	VOC, NO2, others	

2.5.2 Additional Point Sources within Santa Teresa and Sunland Park, New Mexico

The EPA Enviriofacts database identified six additional facilities (Table 2-3), outside the two industrial parks, but within Santa Teresa and Sunland Park, New Mexico as reporting VOC and NOx

emissions. Of these five facilities, two have Title V permits, and are located east of the Santa Teresa air quality monitor. The two Title V facilities that reported NOx and VOC emissions were: 1) El Paso Electric with approximately 1,074 TPY of NOx and 30 TPY of VOC and 2) Camino Real Landfill with approximately 1.6 TPY of NOx and 0.06 TPY of VOC emissions. The Camino Real Landfill and El Paso Electric plant are located approximately 4 to 6 miles east of the 6ZM-Santa Teresa Monitor.

Table 2-3: List of Facilities within Santa Teresa, NM and Sunland Park, NM Reporting NOx and VOC Emissions (*Source: EPA Envirofacts Database, retrieved March 4, 2014*)

Facility	Address	Latitude	Longitude	City	Pollutant Reported	Notes
Rinker Santa Teresa Pipe	"2 MI ON NM 273"	31.85528	-106.63333	Santa Teresa	VOC, NO2, others	
Stew&Steve Pwr Sta Teresa Club	COUNTRY CLUB BLVD & MC NUTT RD	31.84664	-106.62422	Santa Teresa	NO	
Tyson Prepared Foods Inc	5701 MCNUTT ROAD	31.86278	-106.64389	Santa Teresa	VOC, NO2, others	
Camino Real Landfill	2 MILES SW OF AIRPORT"	31.78941	-106.59478	Sunland Park	VOC, NO2, others	Title V Permitted Facility
El Paso Electric - Rio Grande Generating Station"	3501 DONIPHAN ROAD	31.80347	-106.54641	Sunland Park	VOC, NO2, others	Title V Permitted Facility
Four Peaks Energy Plant No1	1000 CAMINO REAL BLVD	31.78953	-106.58542	Sunland Park	VOC, NO2, others	

Figure 2-4 provides a general layout of the location of the facilities located in both Santa Teresa and Sunland Park, New Mexico, relative to the three southern most Doña Ana County air quality monitors (6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa) and west El Paso monitor (C12-UTEP).

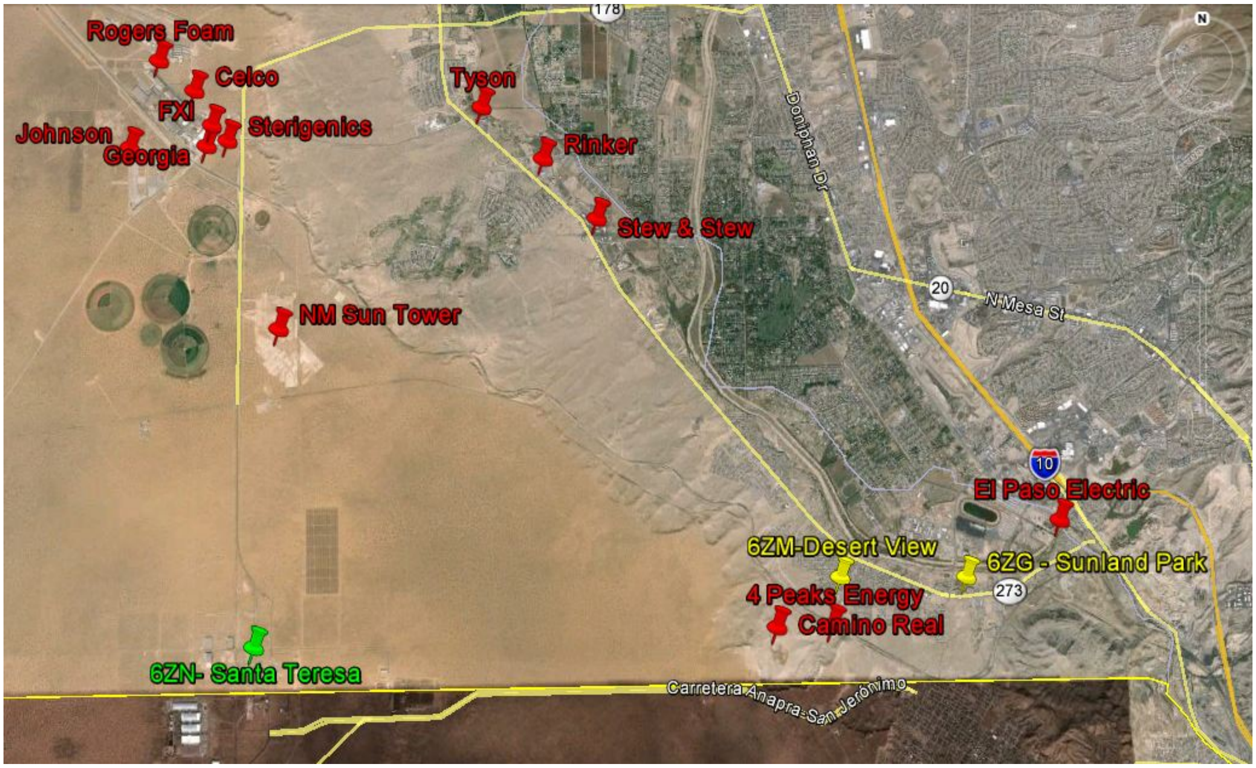


Figure 2-4: Location of Facilities Relative to Air Quality Monitors in Southern Doña Ana County, New Mexico

2.5.3 Foxconn (Jerónimo, Chihuahua)

In 2009, Foxconn, which manufacturers Dell computers, opened the largest maquiladora operating in the country of Mexico in Jerónimo, Chihuahua. This location is expected to be an industrial mega complex, eventually comprised of an area over 240 hectares (Vázquez, 2010) with a future projection of employing over 20,000 persons. Currently, Foxconn is operating with approximately 7,000 to 8,000 employees working at the facility (Vázquez, 2010). In addition, part of this development of Foxcomm property, includes the future construction of a solar energy park and nanotechnology research center.

Correspondence with Mexican environmental agencies indicated the only emissions reported for Foxconn were those associated with HVAC systems; this facility is more of an assembly plant with no manufactory processes. As a note, in general, this type of electronic manufacturing industry generally is associated with VOC emissions from the use of solvents used for the production of electronic components utilized in the computers as well as other processes within the facility (Wang et al., 2013).

Considering the information given regarding Foxconn operations, the only NOx and VOC emissions considered for this operation are from mobile sources associated with the increase in vehicle traffic associated with the operations of the facility (i.e. delivery and shipping trucks traveling to and from the site) as well as vehicle traffic associated with employee travel to and from the site.

2.5.4 Union Pacific Intermodal Rail Facility

In 2009, Union Pacific (UP) began construction on a new fueling and transshipment center in the Santa Teresa industrial zone (Figure 2-5). The facility will allow cargo containers to be transferred between rail cars and trucks leaving or arriving at Santa Teresa UP facility. This UP facility will be the largest UP facility along the U.S.-Mexico border. According to the New Mexico Border Authority, the UP facility is expected to bring an additional 500 to 800 commercial trucks daily, traveling to and from Santa Teresa area (Villagran, 2014). This increase in truck traffic will introduce additional NOx and VOC emissions into the Southern Doña Ana County. In addition, the increase in rail traffic in the county will also increase the NOx emissions associated with rail transportation for study area. Before the operation of the UP facility, the NMED emission inventory showed that approximately 103 TPY of NOx and 4 TPY of VOC is associated with rail traffic in Sunland Park, NM.

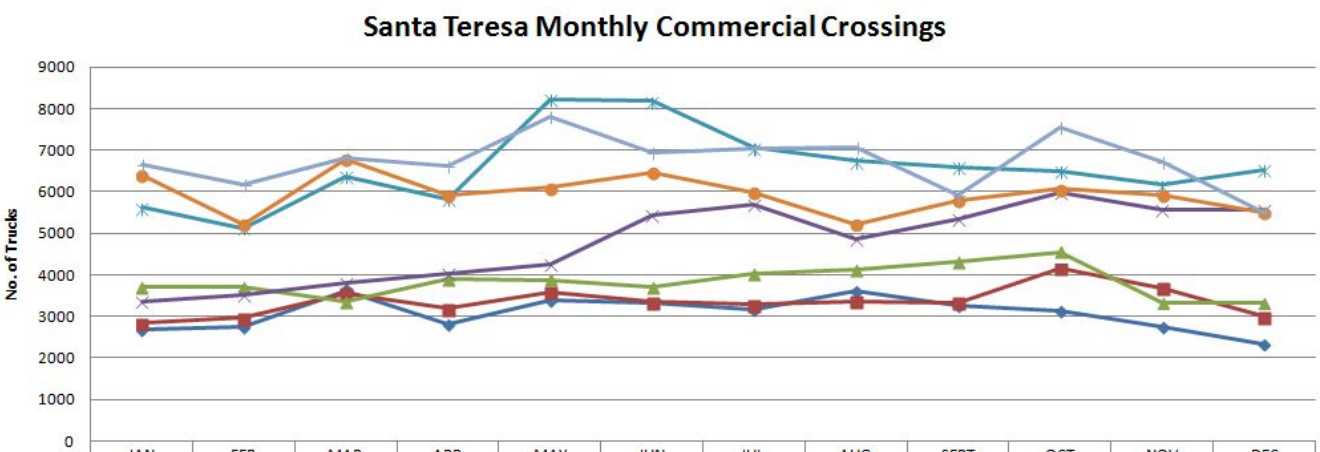
Figure 2-5: Santa Teresa, New Mexico – Jerónimo, Chihuahua Trade Zone *(Source: Mesilla Valley Economic Development Alliance, 2014)*

2.5.5 Santa Teresa, New Mexico – San Jerónimo, Chihuahua Port of Entry

With the expansion of industry operations both north and south of the border, there have also been measures taken to expand the capacity of the Santa Teresa POE to handle the increase in passenger and commercial traffic. In May 2013, the POE expanded by two additional commercial and two privately operated vehicle (POV) traffic lanes bringing the total commercial lanes to three and POV lanes to four. During this time, the POE also broke ground on a $12 million inspection station for northbound commercial truck traffic. Other efforts include the state of “New Mexico approving the commercial zone to be designated for “overweight” traffic, that is, cargo with up to 96,000 lbs of

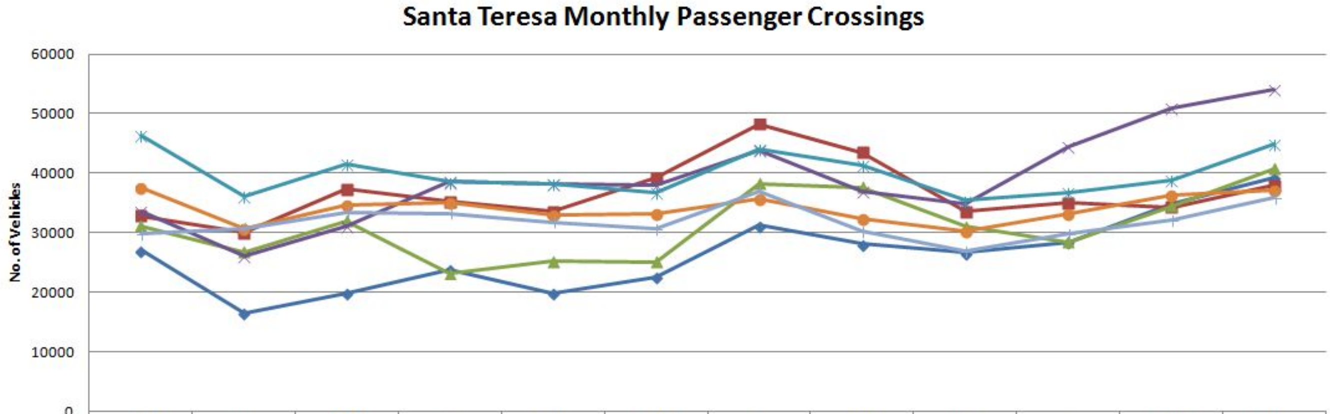
weight, or approximately 16,000 lbs that is permitted by federal law in U.S. Highways" (Robinson-Avila, 2013).

Figure 2-6, Figure 2-7, and Figure 2-8 provide an overview of the Northbound border traffic crossings for commercial and passenger vehicles between 2006 through 2012. (Note: For Figure 2-8, the 2013 year border crossing statistics are projected figures). Although no statistics were available for southbound traffic, it can safely be assumed that the majority of the traffic would be returning southbound. Both in 2010 and 2012, the number of commercial trucks crossing the POE increased in the month of June. POV traffic seemed to show higher crossing in the months of August, December and January for all years. The POV traffic increase is more than likely due to the number of summer vacation travelers for August and holiday travelers for January and December.



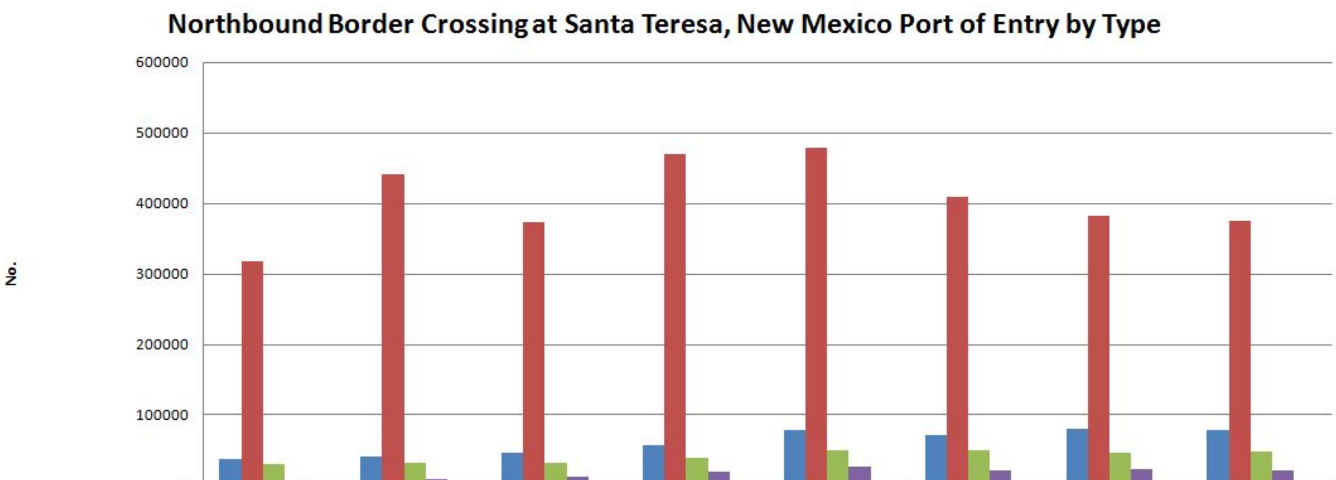
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
2006	2686	2756	3628	2809	3400	3318	3180	3620	3267	3146	2761	2334
2007	2837	2962	3550	3185	3589	3344	3283	3372	3318	4149	3688	2990
2008	3695	3705	3347	3893	3877	3712	4016	4114	4313	4544	3320	3320
2009	3366	3508	3812	4029	4266	5424	5698	4860	5353	5969	5561	5564
2010	5618	5125	6373	5820	8216	8176	7055	6732	6589	6487	6160	6528
2011	6394	5224	6773	5921	6097	6465	5987	5224	5785	6067	5924	5501
2012	6641	6182	6798	6607	7799	6950	7040	7064	5901	7547	6723	5492

Figure 2-6: Commercial Truck Monthly Northbound Crossings from 2006 through 2012 *(Source: Bureau of Transportation Statistics-RITA, 2014)*



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
2006	27089	16483	19865	23788	19905	22565	31238	28078	26616	28484	34763	39221
2007	32868	29958	37264	35248	33622	39269	48253	43503	33565	35085	34323	37899
2012	31173	26786	31967	23135	25197	25075	38279	37615	31039	28485	34445	40709
2009	33576	26007	31151	38678	38182	37912	43891	37000	34761	44532	50960	53975
2010	46342	36204	41544	38513	38168	36785	44047	41350	35430	36833	38837	44917
2011	37474	30677	34616	35005	32935	33111	35628	32436	30176	33160	36273	37123
2012	29879	30760	33495	33288	31809	30659	36916	30207	26986	29781	32159	35964

Figure 2-7: Passenger Vehicle Monthly Northbound Crossings from 2006 through 2012 *(Source: Bureau of Transportation Statistics-RITA, 2014)*



	2006	2007	2008	2009	2010	2011	2012	2013
Trucks	36905	40267	45856	57410	78879	71362	80744	79145
Passenger	318095	440857	373905	470625	478970	408614	381903	375257
Loaded Truck Containers	29489	31593	32788	38763	49384	50150	45567	48585
Empty Truck Containers	7567	8662	12165	18750	26835	21072	23146	22248
buses	122	164	341	329	440	315	258	252

Figure 2-8: Northbound Border Crossings by Vehicle Type from 2006 through 2013 *(Source: Bureau of Transportation Statistics- RITA, 2014)*

Between the years 2006 through 2013, the number of commercial truck crossings increased by 114% (Figure 2.8) from 36,905 to 79,145, while passenger vehicle crossing increased by 17% from 318,095 to 375,257.

From 2004 to 2009, average border wait times for POV traffic ranged from less than a minute to a maximum of 15 minutes, with an average wait time of approximately five minutes (CTR & TTI, 2013). For commercial traffic the wait times were reported between one to three minutes, with an average wait time of one minute. More recent data from 2013 provided by Customs and Border Protection (CBP) showed that POV wait times varied between a few minutes up to 150 minutes, depending on the day and time of day border crossings occurred. The following graphs provided by the University of California, which took the most recent data from CBP, showed that currently POV average wait times ranged from a couple of minutes to approximately 30 minutes, with Saturday being the day with longest average wait time during a week (Figure 2-9). Commercial vehicle average wait times ranged from 5 minutes to 11 minutes, with several weekdays indicating longer average wait times in the morning hours between 8 to 11 A.M. and 3 to 6 P.M. (Figure 2-10).

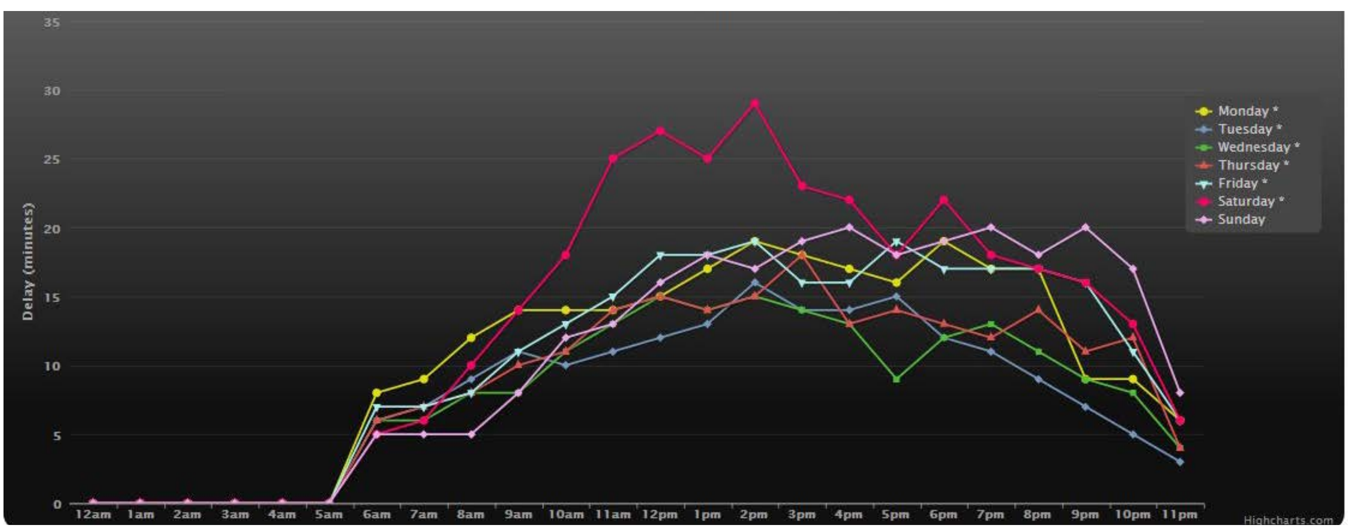


Figure 2-9: Northbound Passenger Vehicle Traffic Average Wait times for Santa Teresa POE for 2014
(Source: University of California, 2014)

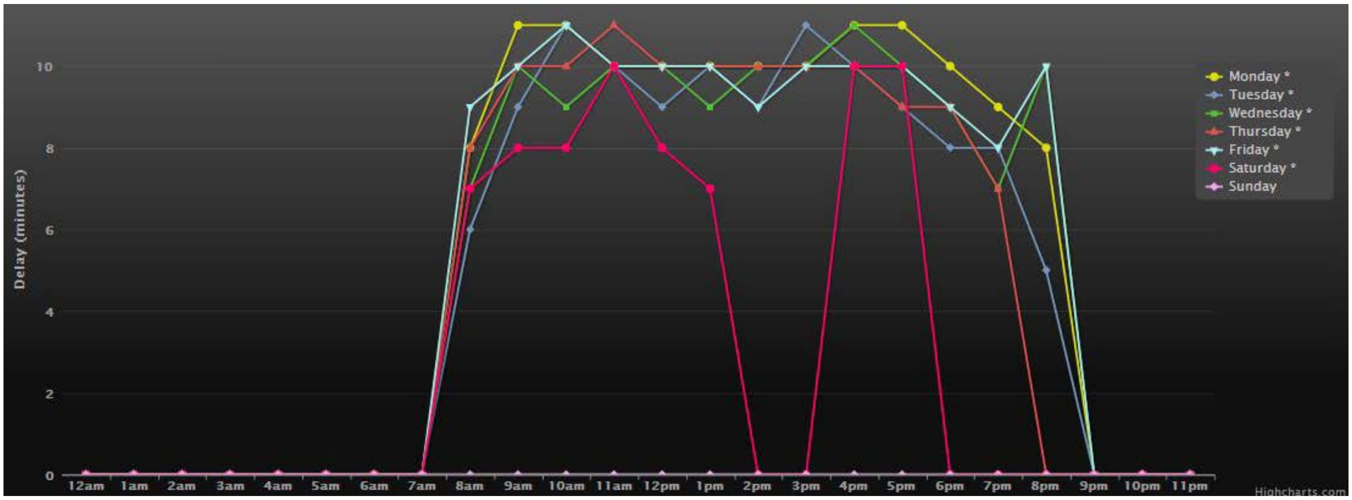


Figure 2-10: Northbound Commercial Vehicle Traffic Average Wait times for Santa Teresa POE for 2014 *(Source: University of California, 2014)*

Figures 2-11 through Figures 2-17 showed the maximum hourly wait times for Monday through Sunday for northbound passenger vehicle traffic. The maximum hourly wait time for vehicle traffic at the Santa Teresa POE occured each day between the hours of 2 to 10 P.M.; with Monday (Figure 2-10), Thursday – Saturday (Figure 2-13 through Figure 2-15) being the days where the highest maximum hourly average wait times are observed. The data also indicated that POVs can wait as much as 150 minutes (Figure 2-16: Saturday 8 P.M.) before crossing the border. Maximum hourly data for commercial traffic (Appendix A: Figures A1 through A6), for Monday through Saturday, is not as high as that observed in passenger vehicle traffic. (Note: The commercial lanes at the Santa Teresa POE are closed Sundays). The maximum hourly wait time for commercial vehicles crossing into the U.S. was 30 minutes, with vehicle wait times peaking at different times each day of the week: 11 A.M. on Monday; 3 P.M. on Tuesday; 5 P.M. on Wednesday; 11 A.M., 4 P.M. and 6 P.M. on Thursday; 11 A.M. on Friday and 1 P.M. on Saturdays.

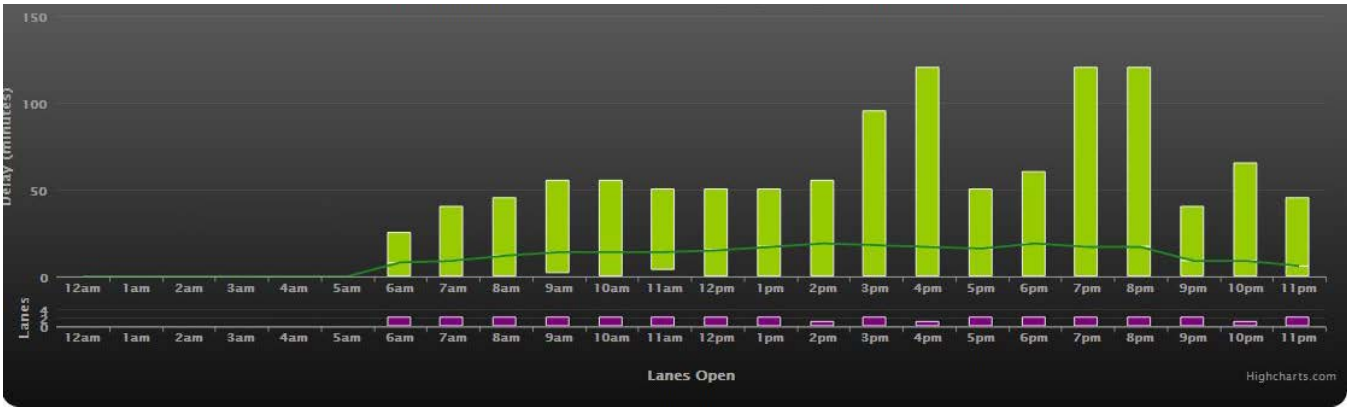


Figure 2-11: Monday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 Northbound Passenger Vehicles *(Source: University of California, 2014)*

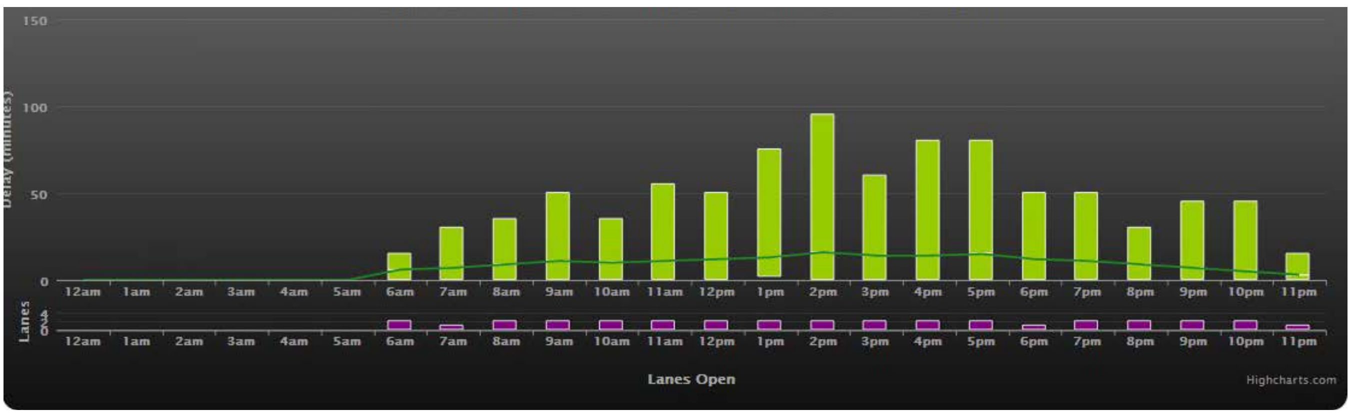


Figure 2-12: Tuesday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 Northbound Passenger Vehicles *(Source: University of California, 2014)*

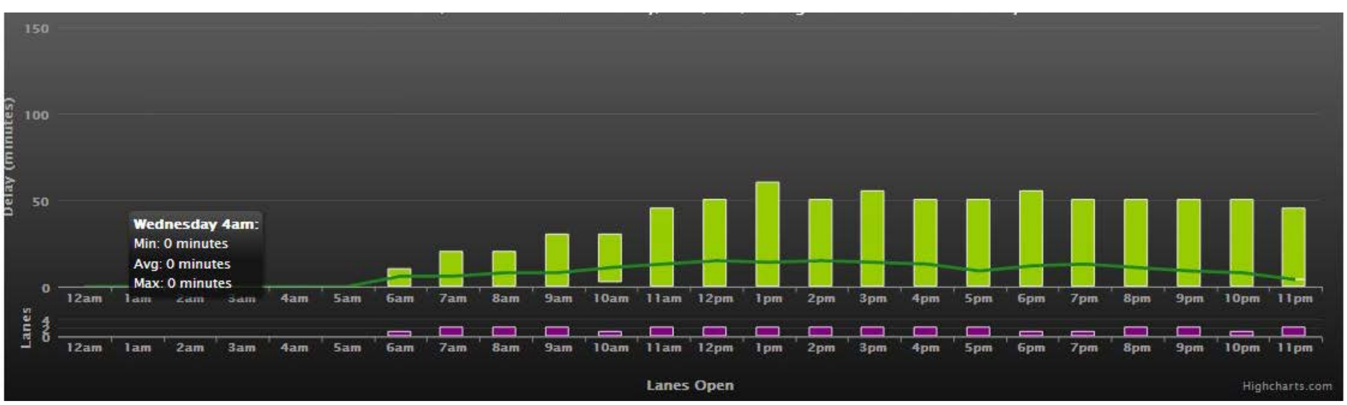


Figure 2-13: Wednesday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 Northbound Passenger Vehicles *(Source: University of California, 2014)*

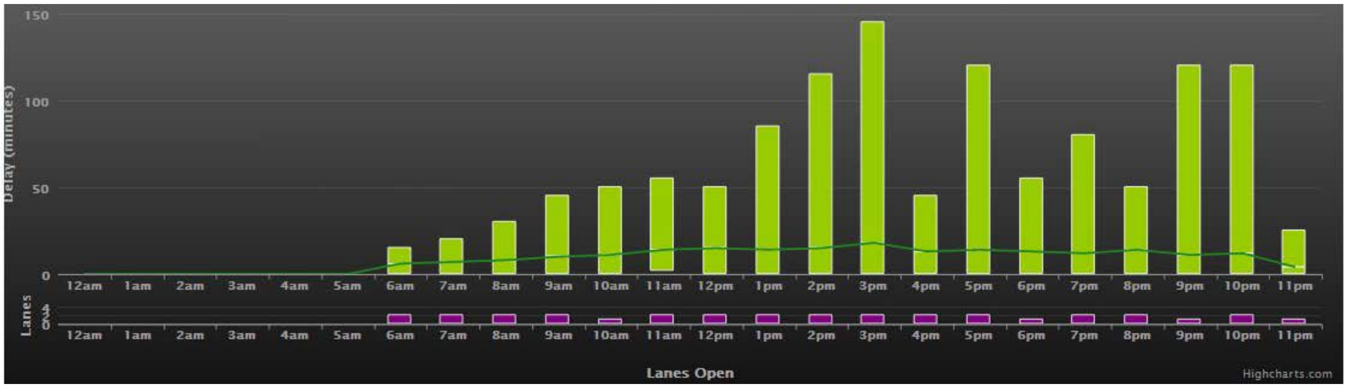


Figure 2-14: Thursday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 Northbound Passenger Vehicles *(Source: University of California, 2014)*

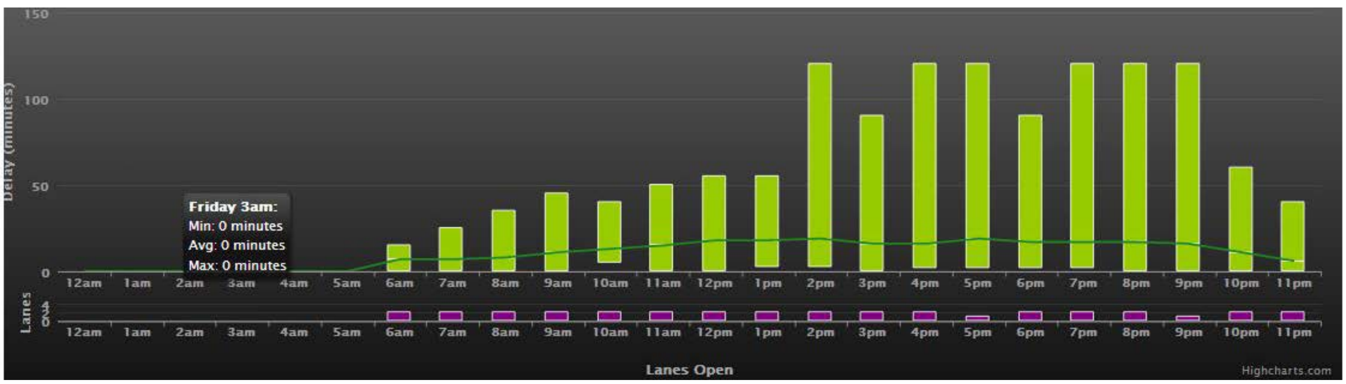


Figure 2-15: Friday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 Northbound Passenger Vehicles *(Source: University of California, 2014)*

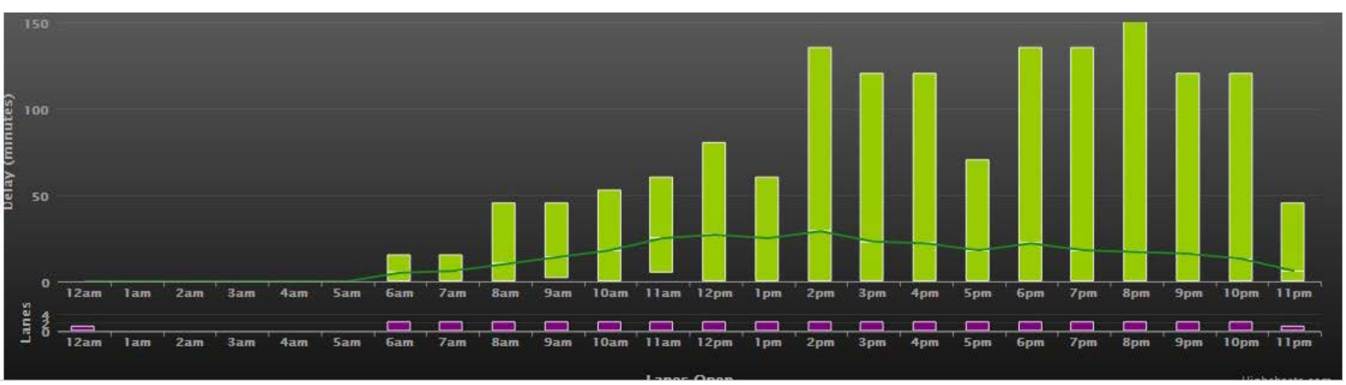


Figure 2-16: Saturday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 Northbound Passenger Vehicles *(Source: University of California, 2014)*

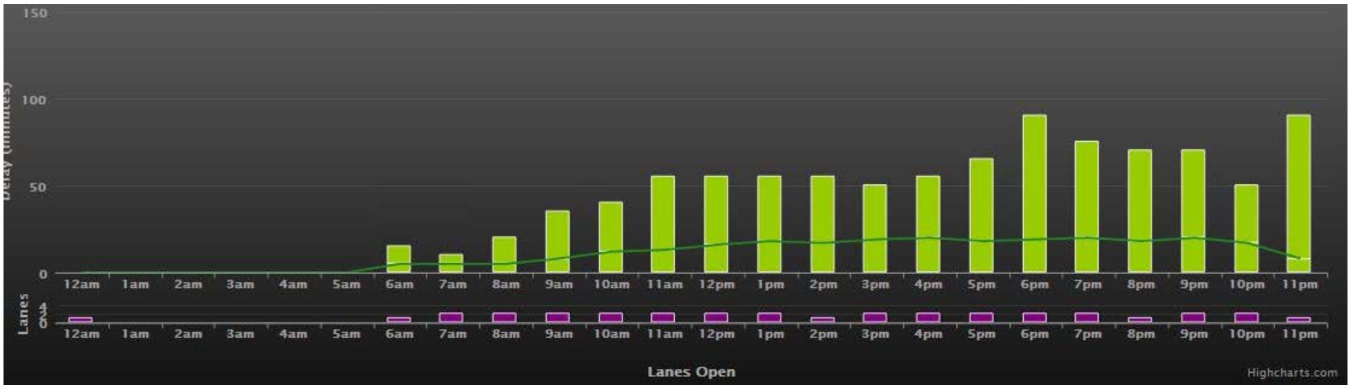


Figure 2-17: Sunday Hourly Average and Maximum Wait times for Santa Teresa POE for 2014 Northbound Passenger Vehicles *(Source: University of California, 2014)*

To date, no traffic or emission related studies have been conducted for the Santa Teresa POE. However, regional studies point out that the port of entries can lead to "hot spots" where NOx and VOC emissions are concentrated locally, due to the idling of POV and commercial traffic. A recent study by the University of Texas at El Paso (UTEP) as part of the Rider 8 Program for the State of Texas, concluded NOx and VOC emissions from El Paso POEs account for approximately 5.5% and 2%, respectively, of total on road NOx and VOC emissions (Yang et al., 2012) for El Paso. Depending on the number of passenger to commercial traffic, idling time and inspection time, either type of vehicle traffic could be a significant emission source for NOx or VOC at a POE. For example, at the Bridge of the Americas POE, NOx emissions from passenger traffic was greater than commercial traffic; whereas at the Ysleta-Zaragoza POE, NOx emissions from commercial traffic was almost double of that for the passenger vehicle traffic (Yang et al., 2012). Another study conducted by the U.S. Department of Transportation Federal Highway Administration (Kear et al., 2012) concluded that for the Ysleta-Zaragoza POE approximately half of the emissions associated with traffic crossing at the POE are from delay and queuing activities. Although the Santa Teresa POE does not see the traffic volume that El Paso POEs experience, as the region continues to expand its commercial development, the increased vehicle traffic associated with border crossings could begin to play a much greater role in terms of area source emissions of NOx and VOCs.

2.5.6 Vehicle Exportation Operation at Santa Teresa Port of Entry

Beginning in 2002, the Santa Teresa POE also became the region's primary designated POE for vehicle exportation from the United States into Mexico in the region. Before this, the Ysleta POE was used for vehicle exportation; however, due to the number of vehicles being crossed every day, along with daily traffic at the POE and security considerations, this operation was moved to the Santa Teresa POE, which sees significantly less traffic compared to the POEs in El Paso. From 2011 to 2013, approximately 155,095 cars were exported from the US into Mexico.

When the operation moved to Santa Teresa, every weekday, vehicles (i.e. old cars, vans, trucks and other types) would begin to line up along a spur off Pete Domenici highway very early in the morning (Crowder, 2013). On any given day, by midmorning, as many as 300 cars waited in line to cross into Mexico; waiting for a US Customs official to give final paperwork approval. Until 2013, the export process would take all day before US and Mexican Customs processed the cars to be exported. In February 2013, the US CBP implemented an electronic online system to process the US side of the paperwork in order to reduce the wait time for vehicle exportation from the US side. However, cars still need to be properly process from the Mexican side. This process adds additional NOx and VOC emissions from mobile sources waiting to cross or be taken into Mexico.

Chapter 3: Methodology

3.1 Wind Rose and Ozone Pollution Rose Overview

WRPLOT View, developed by Lakes Environmental, was utilized to construct wind and pollution roses for the stations: 6ZM-Santa Teresa (ST), 6ZM-Desert View (DV), 6ZG-Sunland Park (SP), and C12-UTEP (UT). A wind rose analysis was conducted to help identify the transport ozone and/or precursors, from local sources that contribute to ozone pollution in the study area. A wind rose plot is a way to graphically present the frequency of winds by direction and speed at a given location over a period of time. Wind roses can depict an area's dominant transport direction of an area's wind at a particular monitoring location. Wind roses from several monitoring stations were used as a way to "triangulate" or identify local sources by the prevailing wind directions from these stations. If several monitoring stations "point" to a common location, then it could be stated that this location contributes to the ozone pollution at these downwind monitoring site. This approach has been used both for academic research and regulatory purposes.

The wind rose plots were used to visualize the frequency of incoming winds to each station during the ozone seasons 2006 to 2013. The wind roses were developed utilizing hourly wind speed and direction for high ozone days, between 10 A.M. to 6 P.M. The wind roses generated were divided into 16 wind direction categories (22.5 degrees per category). For a particular direction, the length of the colored segment indicates the relative frequency of six wind speeds for that wind direction.

The pollution rose is similar to a wind rose; however, ozone concentration is substituted for wind speed. A pollution rose is a tool that can be utilized to assess the characteristics of pollutant transport arriving at the monitor location (EPA, 2008). The pollution roses developed utilized 16 wind direction categories (22.5 degrees per category). For a particular direction, the length of the colored segment indicates the relative frequency of ozone concentration arriving or measured at the monitoring station for that wind direction. It should be noted that wind and pollution roses may not be indicative of the "synoptic scale flow of a region as turbulent and synoptic nature of wind leads to changes in wind direction over a region, which is not reflective in local or point wind direction measurements" (Fleming, et al., 2012).

Hourly data used to create the wind and pollution roses were resultant wind speed, wind direction and ozone concentrations, which were obtained from the TCEQ, NMED and EPA databases, mentioned earlier.

3.2 Description of Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) Model

The National Oceanic and Atmospheric Administration (NOAA) Air Resource Laboratory (ARL) developed the HYSPLIT model utilized for this project. The model is capable of calculating particle trajectories either forward or backward in time, as well as simulating dispersion or deposition by using forecast or archived meteorological data (Draxler & Hess, 1997). HYSPLIT was utilized for creating a 72-hour trajectory cluster analysis for 2006, 2012 and 2013, as well as backward trajectories for the three high ozone days in 2013 for the Santa Teresa monitoring station.

Backward trajectories analysis is an established tool for air quality studies to better understand the origin of an air parcel in time over a distance (Fast & Berkowitz, 1997). Backward trajectory analysis was conducted for high ozone days specifically, to help identify potential long-range transport of ozone precursor pollutants from a particular region that may be contributing to ozone pollution in the study area. In general, the model can also be used to better understanding synoptic meteorology in an area, climatology and model source contribution or direction of a pollutant released into the environment in emergency response events (Draxler & Hess, 1998).

The trajectory of a particle in the HYSPLIT model is calculated by the integration of a particle position vector in space based on wind velocity and time (Draxler & Hess, 1997). Trajectory calculations consist of the advection of a particle computed from the average of three-dimensional velocity vectors (U, V, and W). Position (P) is computed from an average velocity (V) from the initial P(t) with a first guess $P'(t + \Delta t)$ is

$$P'(t + \Delta t) = P(t) + V(P,t)\Delta t \tag{3.1}$$

The final position is

$$P(t+ \Delta t) = P(t) + 0.5 [V(P,t) + V(P',t+ \Delta t)] \Delta t \tag{3.2}$$

There are three errors that can be associated with a backward trajectory calculation: physical, computational and measurement (Draxler & Hess, 1997). Physical errors refer to how well the numerical fields represent the true flow field. Computational errors are comprised of: 1) integration error due to truncation but is generally a very small error, and 2) resolution error. Measurement errors refer to errors within the meteorological model data (Draxler, 1996; Stohl, 1998).

The HYSPLIT model can be run interactively through the NOAA website or downloaded to a personal computer (PC). There are some limitations in utilizing the online version versus the downloaded PC version; these limitations were set up by NOAA in order to not overload the web server with the requested computations. If utilizing the PC version, the user must download the meteorological data files for the timeframe of interest for trajectory runs. Both the online and PC version have a graphic user interface (GUI), making it easy to utilize and set up the model runs. However, the PC version also gives the user more versatility and access to manipulate the setup, control and various other files directly, if needed.

For backward trajectory analysis, the model gives the option of choosing between eight archived meteorological datasets. The model requires the meteorological data fields to be displayed on a conformal map projection (i.e. Polar Stereographic, Lambert or Mercator) or a latitude-longitude grid. At a minimum, in order to run the model (Draxler, 1999), the following meteorological variables are required: 1) U and V Wind components, 2) ambient temperature, 3) height of the data level (if on pressure coordinates), and 4) surface pressure. Meteorological input files are required to be in a usable HYSPLIT model format. The following archived meteorological datasets are available for use within the model and are downloaded via multiple FTP servers (Draxler, 1999).

- EDAS (Eta Data Assimilation System): 80 km 3P (<=2003 SM 82 Mb) Semi-Monthly data files at three hour intervals on pressure surfaces
- EDAS: 40 km 3P (>=2004 SM 600 Mb) Semi-Monthly data files at three hour intervals on pressure surfaces

- GDAS (Global Data Assimilation System): 1-deg 3P (>=2005 WK 600 Mb) Weekly files (W1=1-7; W2=8-14; W3=15-21; W4=22-28; W5=29-end) every three hours on pressure surfaces
- GDAS: 0.5-deg 3S (>=2010 DA 468 Mb) Daily files every three hours on the native GFS hybrid sigma coordinate system
- NAM12 (North American Mesoscale): 12-km 3P (>=2007 DA 395 Mb) Composite archive 0 to +6 hour forecasts appended into daily files for the CONUS at three hour intervals on pressure surfaces
- NAMs: 12 km 1S (>=2008 DA 994 Mb) Composite archive 0 to +6 hour forecasts appended into daily files for the CONUS at one hour intervals on sigma surfaces
- NAMS_AK: 12 km 1S (>2008 DA 648 Mb) – Specific for use for Alaska
- NAMS_HI: 2 km 1S (>2008 DA 584 Mb) – Specific for use for Hawaii

Once the meteorological data for the time period has been downloaded from the FTP sites, the model is setup through the *Trajectory/Setup Run* menu. Figure 3-1 displays the menu options to initially setup up the model to run. The menu window inputs & options correspond to various lines within the *CONTROL* file of the program. The initial configuration of the model includes: 1) the starting year, month, day, hour; 2) number of starting locations (represents latitude and longitude coordinates and starting height of particle); 3) total run time of model; 4) forward/backward trajectory run; 5) top of the model run (height above which the met data is not processed); 6) vertical motion method; and 7) selection of meteorological data files.

HSYPLIT also allows for the calculations of trajectories in space varying at different heights and locations (*Trajectory Setup Option: Number of starting locations*). That is, the model can simulate the release of a particle at a starting height of “X”, that same particle at a starting height of “Y” and so on. However, the more starting heights and locations that are used, the longer it takes the model to process the information. The default height of a particle is defined to be above-ground level (AGL), however, the model gives the option to changing it to mean sea level within the advanced settings.

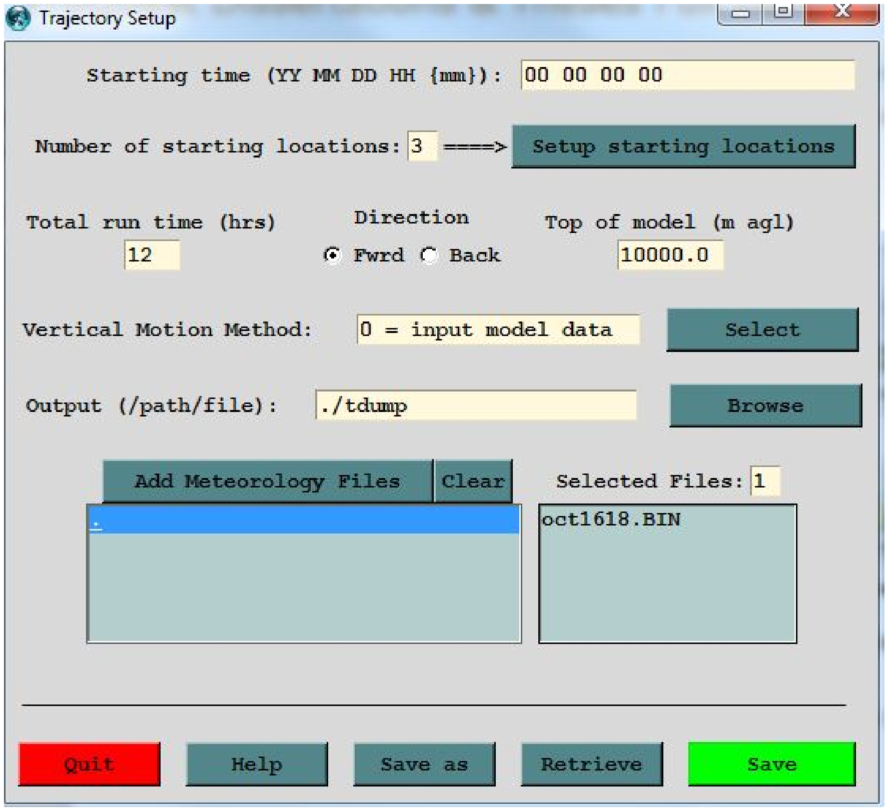


Figure 3-1: HYSPLIT_4 Trajectory Setup Window

A feature within the HYSPLIT model that was utilized for this project was creating daily trajectories for several months. This particular feature is found within the *Trajectory/Special Runs/Daily* menu. The initial trajectory for the month of interest has to first be setup from the Trajectory Setup Menu and then run. The user can then do the setup for the automatic daily trajectories for one month at a time. The year, month, start and end date must be specified (Figure 3-2). The model allows for multiple start hours to be run within each day. For this study, only one starting hour was selected for the daily trajectories.

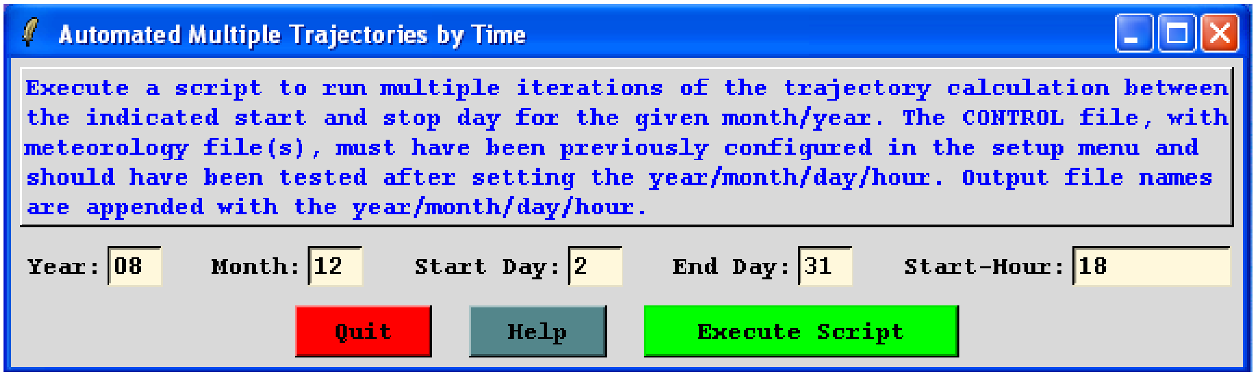


Figure 3-2: HYSPLIT_4 Automated Multiple Trajectories by Time Menu Window

Once the daily trajectories have been run for a month, the user must then again run the initial trajectory setup for the next month and automatic daily trajectories for that month, and so on and so forth, for the entire time period of interest.

Each daily trajectory creates a separate file within the program. These daily trajectories can then be "clustered" together, where similar trajectories are grouped or merged. Cluster analysis is pairing similar clusters until all the trajectories are in one cluster. The cluster process begins by assuming each trajectory is its own cluster. As clusters are combined, the spatial variance of the clusters and total spatial variance (TSV - sum of the spatial variances) is calculated. When different clusters are combined, there is a large increase in TSV. Throughout the analysis there may be several "large" increases in the TSV, such as that in Figure 3-3, which is a graphic display file the user utilizes in determining the "best" number of clusters. Ideally the best choice for choosing the number of clusters is that point to the left on the plot (Figure 3-3, red arrows) before the first large increase in TSV. Depending on the data, the best choice for determining the appropriate number of clusters may not be obvious; therefore the choosing of clusters is subjective. In the end, the differences between trajectories in a given cluster are minimized and differences in clusters is maximized (HSYPLIT Workshop, 2012). The clustering technique can be used as a statistical tool to help understand the percent of possible emission sources to an area from various spatial directions. The program gives the option of displaying the various clusters with the individual trajectories within those clusters, or a cluster-mean of the various trajectories.

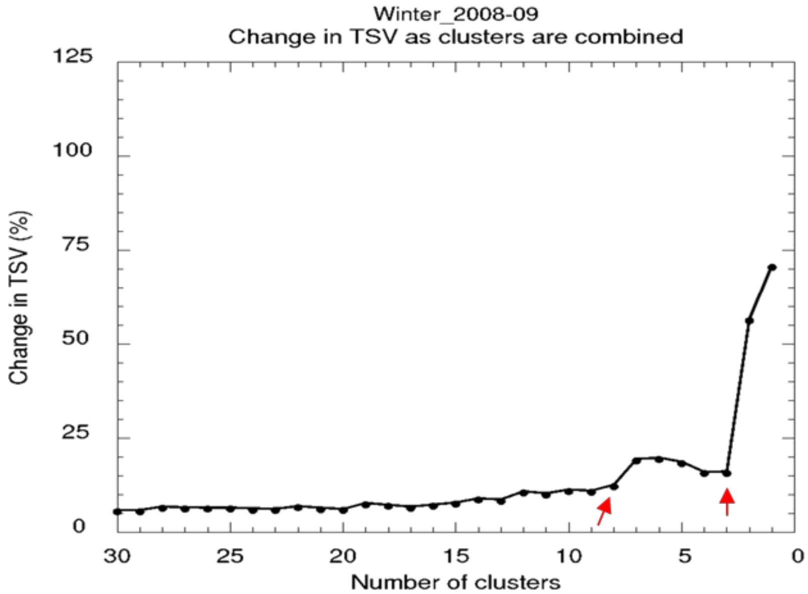


Figure 3-3: Example of Total Spatial Variance (TSV) Graph
(Source: NOAA, HYSPLIT Hands-on Part 5 Workshop)

Once the model has been run, whether it's a single trajectory, daily or multiple trajectories or cluster analysis, HYSPLIT gives the option of outputting these trajectories into a nice graphic display. HYSPLIT also gives the option of creating a (*.kmz) file for the daily or multiple trajectories. This file can then be imported into Google Earth, allowing the user to follow the trajectory in a 3-D setting.

Chapter 4: Air Quality Monitoring at Sunland Park, New Mexico

4.1 New Mexico Environment Department Monitoring Network for Southern Doña Ana County, New Mexico

The Clean Air Act places the responsibility on states to establish a network of air monitoring stations to ensure air quality standards are met or attained with regards to the six criteria pollutants. According to the US EPA (40 CFR Part 58), a monitoring network can consist of four types of monitoring stations: State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), Special Purposes Monitoring Stations (SPMS) and Photochemical Assessment Monitoring Stations (PAMS). The New Mexico Environment Department operates and maintains five SLAM monitors (Table 4-1) within the Southern Doña Ana County area, of which all five of these monitors measure ozone and two measure nitrogen dioxide (NO_2); other criteria pollutants currently measured in the area include Particulate Matter (PM_{10} and $PM_{2.5}$). Since 2007, carbon monoxide (CO) and sulfur dioxide (SO_2) were no longer being monitored in the area of the study due to historical low concentrations measured. (Note: Table 4-1 is not reflective of all the historical monitors, some of which measured CO, are no longer in use. Although $PM_{2.5}$ is measured, it is measured for non-regulatory purposes.)

Table 4-1: Southern New Mexico State and Local Monitoring (SLAMS) Network in Doña Ana County, New Mexico Monitoring Ozone
(*Source: New Mexico Environment Department Air Quality Bureau, 2014*)

Station ID	Station Name/location	Station information	NAAQS Monitored	Date Station Established
350130008	6ZO (La Union); 7048 McNutt	Lat: 31° 55' 50.0154" Long: -106° 37' 50.016" Station Elev.: 3810	0_3, SO_2*	January 1979
350130017	6ZG (Sunland Park); McNutt & Anapra Rd.	Lat: 31° 47' 44.9874" Long: -106° 33' 27" Station Elev.: 3760	0_3, SO_2*, $PM_{2.5}$**, PM_{10}	February 1989
350130020	6ZK (Chaparral); 680 McCombs	Lat: 32°02' 27.9954" Long: 106° 24' 33.012" Station Elev.: 4100	0_3, PM_{10}	February 1996
350130021	6ZM (Desert View); 5935 Valle Vista	Lat: 31° 47' 45.9954" Long: -106° 35' 2.0034" Station Elev.: 3860	NO_2, O_3, $PM_{2.5}$, PM_{10}	February 1996
350130022	6ZN (Santa Teresa); 104-2 Santa Teresa Int. Blvd	Lat: 31° 47' 16.008" Long: -106° 40' 58.0074" Station Elev.: 4100	NO_2, O_3, $PM_{2.5}$**,	January 1996

*SO_2 is no longer being monitored
**$PM_{2.5}$ is measured for non-regulatory purposes

4.2 Air Quality Databases

4.2.1 New Mexico Environment Department (NMED) Monitoring Network

Air quality data for New Mexico stations can be obtained from the NMED website (http://drdasnm1.alink.com/). However, at the time of this study, NMED was in the process of migrating air quality data to a new web system, therefore, data utilized for this report was provided directly by NMED Air Quality Bureau staff. Hourly data for the five southern Doña Ana County monitors for the period of January 2006 – September 2013 was provided by NMED staff. The hourly parameters were:

- maximum ozone concentration (ppm),
- solar Radiation (w/m2),
- temp_2m (Degree Celsius),
- temp_10 (Degree Celsius),
- delta_T (Degree Celsius),
- wind Speed S (m/s),

- wind Dir S (Degrees),
- sigma (Degrees) and
- wind max (m/s).

4.2.2 Texas Commission on Environmental Quality (TCEQ) Monitoring Network

In this study, two El Paso, Texas monitors (Table 4-2) were included in some data sections of this chapter, for comparisons to New Mexico stations. Data for the Texas monitors, C12-UTEP and C41-Chamizal, were downloaded from the TCEQ website (http://www.tceq.texas.gov) under the website section, Data Reports. The data downloaded included hourly data for January 2006 through September 2013 for the following parameters: 1) Ozone concentration, 2) wind resultant (m/s) and 3) wind resultant direction (degrees).

Table 4-2: TCEQ monitors' C12-UTEP and C41-Chamizal

Station ID	Station Name	Station information	Air Quality data used	Date Station Established
C12	UTEP	Lat: 31° 46' 6" Long: -106° 30' 5" Station Elev.: 1158	0_3	January 1979
C41	Chamizal	Lat: 31° 45' 56" Long: -106° 27' 19" Station Elev.: 1122	0_3	February 1989

4.2.3 U.S. Environmental Protection Agency (EPA)

Data was also obtained from EPA's AirData Home, Monitor Values Report Database Query (http://www.epa.gov/airquality/airdata/ad_rep_mon.html). The data downloaded included daily maximum 8-hour average ozone concentration, for the period of January 2006 through September 2013 for the five southern Doña Ana County monitors (6ZO – La Union, 6ZG – Sunland Park, 6ZK – Chaparral, 6ZM – Desert View, 6ZN – Santa Teresa) and the two El Paso monitors (C12 – UTEP, C41 – Chamizal). Figure 4-1 provides an aerial view of the locations of these monitors within the study area. An overview of the number of days missing a reported daily maximum 8-hour average ozone concentration for both the New Mexico and Texas stations is shown in Figure 4-2. In general, an ozone monitoring day is counted as valid if at least 18 out of 24 running 8-hr averages are available for that

day, that is to say at least 75% of possible hours in a day are available (40 CFR 50: Appendix I: 2.1.2 (b)). For the days with no daily maximum 8-hour average ozone concentration, review of the hourly data indicated that: 1) the data was invalidated due to monitor malfunction, 2) the monitor was being calibrated, or 3) the monitor was being repaired.

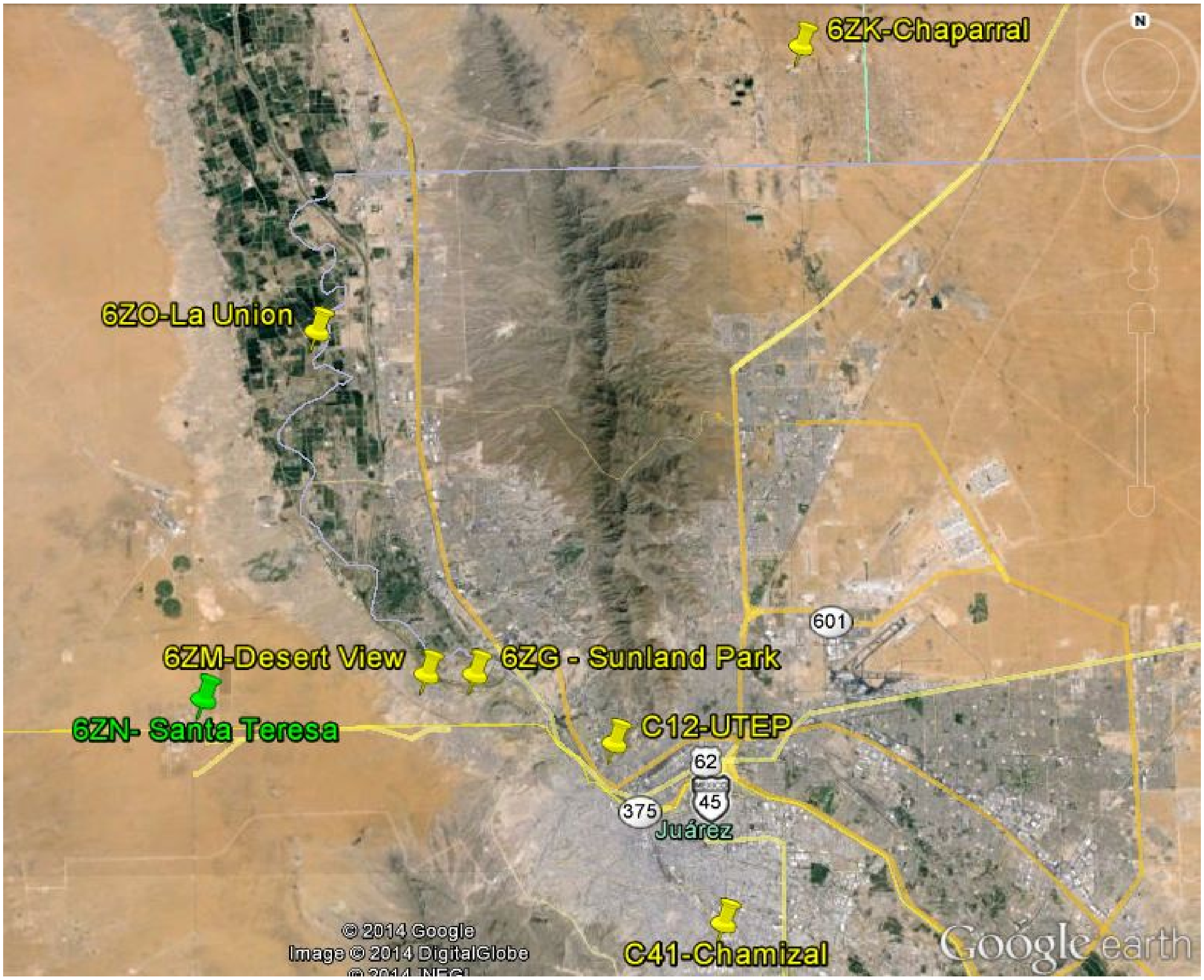


Figure 4-1: Location of 6ZO-La Union, 6ZK-Chaparral, 6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa, C12-UTEP and C41-Chamizal Air Quality Monitors

4.2.4 Ciudad Juarez Monitoring Network

Currently there are five air quality monitors utilized in Ciudad Juarez, Chihuahua which are maintained by the local environmental authorities, Ciudad Juarez Ecology Department. The City of El Paso Environmental Services provides technical assistance to Ciudad Juarez on the monitors. Three out

of the five monitors measure for ozone, relative humidity, temperature and wind (speed and direction). However, due to the locations of these monitors relative to the study area, none of Ciudad Juarez monitors' data was utilized. In addition, although the monitoring information can be downloaded from TCEQ's website, the air quality data is not officially validated by either local or state environmental agencies on either side of the border.

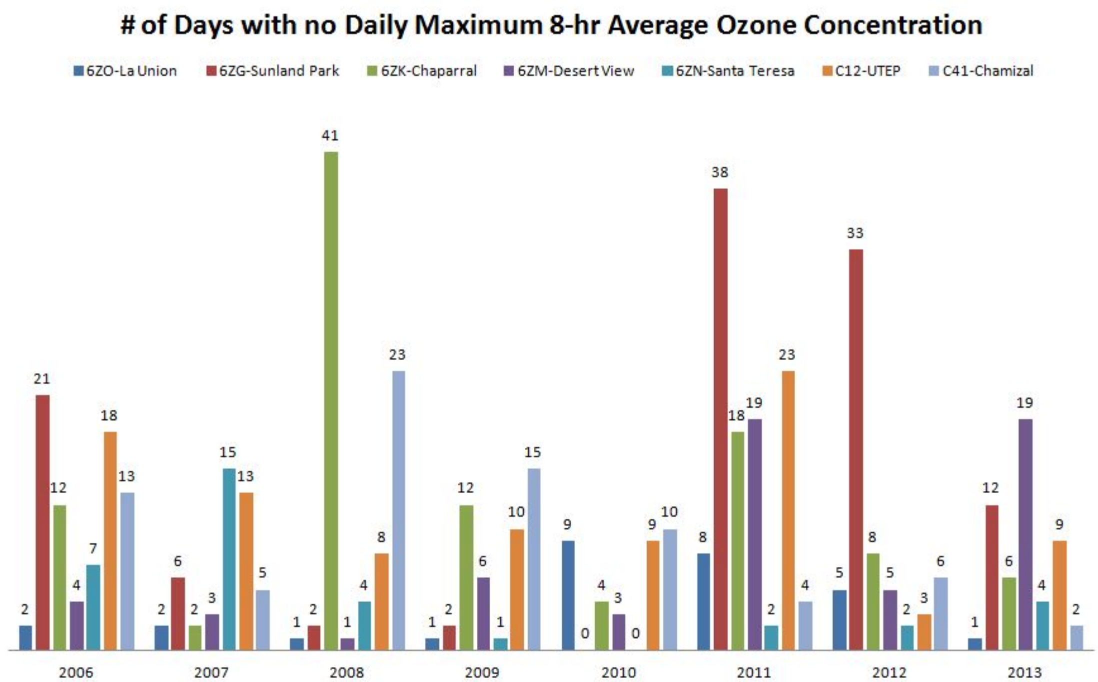


Figure 4-2: Number of Days Missing Daily Ozone Max 8-Hour Average Concentrations from January 2006-September 2013 for Air Quality Stations in Doña Ana (6ZO, 6ZG, 6ZK, 6ZM, 6ZN) and El Paso County (C12, C41)

4.3 Southern Doña Ana County Historical Regulatory Compliance for Ozone from 2006 through 2013

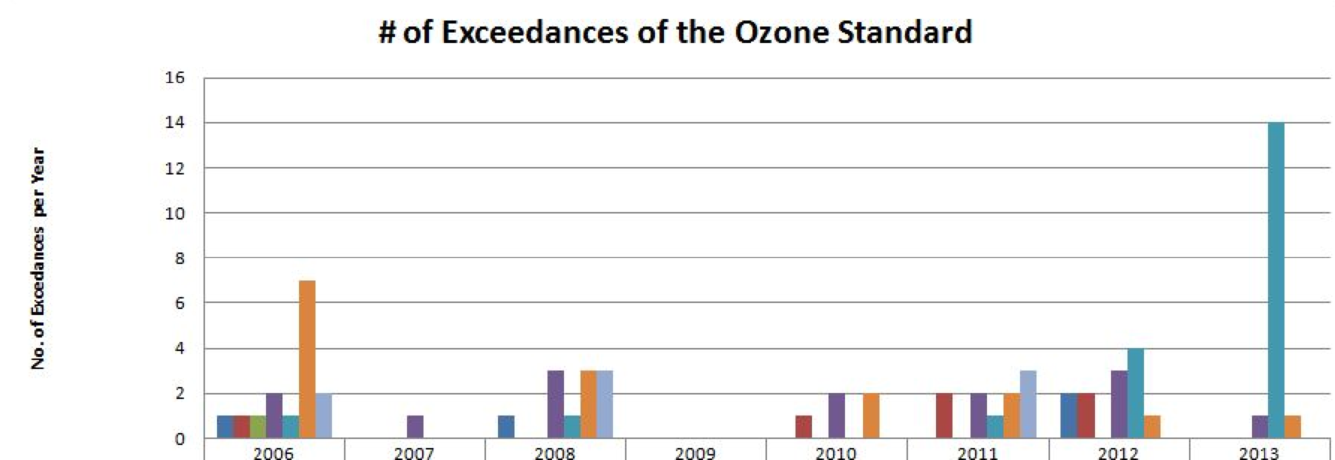
The following section presents eight years of air quality data (from January 2006 to September 2013) as it represents the only available data and relates to the historical compliance within the southern Doña Ana County area for the 8-hour ozone standard. Table 4.3 summarizes the four highest daily maximum 8-hour average ozone concentrations for the years 2006 through 2013 for the five southern Doña Ana county monitors. Ozone levels exceeding the 8-hour NAAQS of 0.075 ppm for ozone are

highlighted in yellow. The 6ZM-Desert View monitor has generally been the monitor with the highest frequency of ozone exceedances in this portion of southern Doña Ana County.

Table 4-3: Top 4 Highest Daily Maximum 8-Hour Average Ozone Concentration Exceedances from January 2006 through September 2013
(*Note: Highlighted values indicate those that were above the 8-hour NAAQS)*

	Year	6ZO-La Union Conc-ppm (date)	6ZG-Sunland Park Conc-ppm (date)	6ZK-Chaparral Conc-ppm (date)	6ZM-Desert View Conc-ppm (date)	6ZN-Santa Teresa Conc-ppm (date)
1st Highest Daily Max 8-hr Avg Ozone Concentrations	2006	0.081 (6/3)	0.086 (8/23)	0.082 (6/18)	0.089 (6/3)	0.081 (6/3)
	2007	0.073 (8/15)	0.076 (7/3)	0.072 (7/9)	0.085 (7/3)	0.079 (7/3)
	2008	0.076 (8/13)	0.069 (9/5)	0.069 (5/14)	0.08 (8/8)	0.076 (7/31)
	2009	0.07 (8/3)	0.065 (8/10)	0.074 (7/31)	0.075 (8/3)	0.068 (8/3)
	2010	0.07 (7/19)	0.084 (7/13)	0.07 (7/20)	0.081 (7/13)	0.067 (9/28)
	2011	0.064 (5/24)	0.078 (6/22)	0.074 (8/2)	0.084 (6/4)	0.078 (6/22)
	2012	0.079 (8/31)	0.078 (8/31)	0.075 (6/2)	0.077 (7/13)	0.083 (8/31)
	2013	0.066 (8/17)	0.068 (7/3)	0.074 (5/24)	0.076 (7/3)	0.089 (7/27)
2nd Highest Daily Max 8-hr Avg Ozone Concentrations	2006	0.079 (7/28)	0.077 (7/28)	0.073 (6/5)	0.082 (8/23)	0.073 (5/14)
	2007	0.072 (7/3)	0.07 (6/10)	0.07 (6/14)	0.08 (6/10)	0.076 (6/10)
	2008	0.074 (8/22)	0.067 (6/9)	0.068 (6/6)	0.079 (8/7)	0.073 (8/6)
	2009	0.066 (7/24)	0.065 (8/29)	0.072 (8/6)	0.072 (7/24)	0.066 (5/28)
	2010	0.065 (9/4)	0.068 (7/19)	0.068 (6/23)	0.081 (8/23)	0.065 (4/7)
	2011	0.064 (6/22)	0.076 (6/4)	0.073 (5/24)	0.081 (6/22)	0.074 (5/24)
	2012	0.078 (7/13)	0.076 (7/13)	0.07 (6/1)	0.077 (8/31)	0.08 (7/13)
	2013	0.065 (8/16)	0.063 (6/9)	0.074 (6/15)	0.072 (7/27)	0.081 (7/25)
3rd Highest Daily Max 8-hr Avg Ozone Concentrations	2006	0.073 (6/29)	0.074 (7/4)	0.073 (6/3)	0.08 (7/4)	0.073 (6/12)
	2007	0.069 (7/16)	0.07 (7/2)	0.07 (9/12)	0.076 (7/16)	0.073 (5/19)
	2008	0.073 (8/7)	0.066 (8/4)	0.067 (6/5)	0.077 (9/5)	0.073 (8/7)
	2009	0.065 (4/20)	0.065 (9/13)	0.068 (7/14)	0.067 (7/31)	0.065 (5/11)
	2010	0.061 (8/27)	0.067 (8/20)	0.067 (7/13)	0.072 (9/28)	0.065 (10/1)
	2011	0.064 (7/28)	0.068 (7/28)	0.071 (5/25)	0.073 (8/27)	0.07 (4/26)
	2012	0.075 (6/28)	0.075 (7/12)	0.069 (7/13)	0.076 (7/12)	0.078 (7/12)
	2013	0.065 (8/21)	0.063 (6/11)	0.071 (7/3)	0.072 (8/16)	.081 (7/3)
4th Highest Daily Max 8-hr Avg Ozone Concentrations	2006	0.072 (6/2)	0.073 (7/11)	0.072 (6/4)	0.08 (7/28)	0.073 (6/22)
	2007	0.068 (3/17)	0.07 (7/2)	0.068 (7/15)	0.076 (9/12)	0.073 (6/16)
	2008	0.071 (6/22)	0.065 (6/22)	0.067 (6/9)	0.074 (8/4)	0.072 (8/4)
	2009	0.063 (5/9)	0.063 (8/3)	0.067 (6/26)	0.066 (5/9)	0.065 (6/3)
	2010	0.06 (5/12)	0.066 (8/23)	0.065 (5/12)	0.07 (8/20)	0.064 (5/12)
	2011	0.063 (4/26)	0.067 (6/27)	0.07 (6/22)	0.072 (7/28)	0.07 (6/27)
	2012	0.074 (7/14)	0.073 (6/28)	0.067 (6/3)	0.075 (6/28)	0.077 (9/1)
	2013	0.064 (8/4)	0.062 (6/10; 8/16; 8/17)	0.07 (7/5)	0.071 (4/28; 6/9)	0.08 (7/7)

Although exceedences may occur throughout the year when a daily maximum 8-hour average ozone concentration is above the standard, it does not necessarily constitute a violation of the ozone standard. Figure 4-3 presents the total number of days exceeding the ozone standard for a given year between 2006 and 2013. The 8-hour standard changed in 2008 to 0.075 ppm, therefore, the number of exceedances for 2006 and 2007 annual years are based on the previous standard of 0.08 ppm. The two El Paso monitors, C12-UTEP and C41-Chamizal are also included in this figure. Overall, a general trend of less ozone exceedances throughout the years was observed at C12-UTEP, while the trend at C41-Chamizal is not as conclusive. With regards to the trend at New Mexico monitors, ozone exceedances per year were consistently observed at 6ZM-Desert View, with 1 to 3 exceedances per year. The 6ZN-Santa Teresa monitor saw an increase in ozone exceedances for 2012 and 2013, with 4 exceedances and 14 exceedances, respectively, which when compared to prior years, very little if any exceedances were observed. The other New Mexico monitors (6ZO-La Union, 6ZG-Sunland Park, 6ZK-Chaparral) all showed a general trend of very low exceedances, if any.



	2006	2007	2008	2009	2010	2011	2012	2013
6ZO-La Union	1	0	1	0	0	0	2	0
6ZG-Sunland Park	1	0	0	0	1	2	2	0
6ZK-Chaparral	1	0	0	0	0	0	0	0
6ZM-Desert View	2	1	3	0	2	2	3	1
6ZN-Santa Teresa	1	0	1	0	0	1	4	14
C12-UTEP	7	0	3	0	2	2	1	1
C41-Chamizal	2	0	3	0	0	3	0	0

Figure 4-3: Number of days with Daily Max 8-Hour Average Ozone Concentrations exceeding standard from January 2006 through September 2013 for Air Quality Stations in Doña Ana County (6ZO, 6ZG, 6ZK, 6ZM, 6ZN) and El Paso County (C12, C41)

Compliance with the primary and secondary ozone standard is met when the 3-year average of the annual 4th highest daily maximum 8-hour average ozone concentration is less than 0.075 ppm, which is also the air quality design value of a monitoring site. Historically, the 6ZM-Desert View monitor has been the monitor that the Doña Ana County's design value is based on. Since the implementation of the 8-hour NAAQS in 1998, the county has been in compliance of the 8-hour ozone standard. Figure 4-4 indicates the design values for the five southern Doña Ana County monitors for years 2006 through 2013. It should be noted, 2013 design values are subject to change due to the fact that 2013 monitoring data has not been validated by NMED staff. States have until May 1 of the following year to submit the final validated data for the previous calendar year to EPA. Beginning 2011 to 2012, a general upward trend in design values was in all of the monitors, with the 6ZN-Santa Teresa monitor continuing this trend for in 2012 and 2013. If the 2013 air quality monitoring data does not change once validated by NMED, 6ZN-Santa Teresa monitor will have the highest design value for the Doña Ana County.

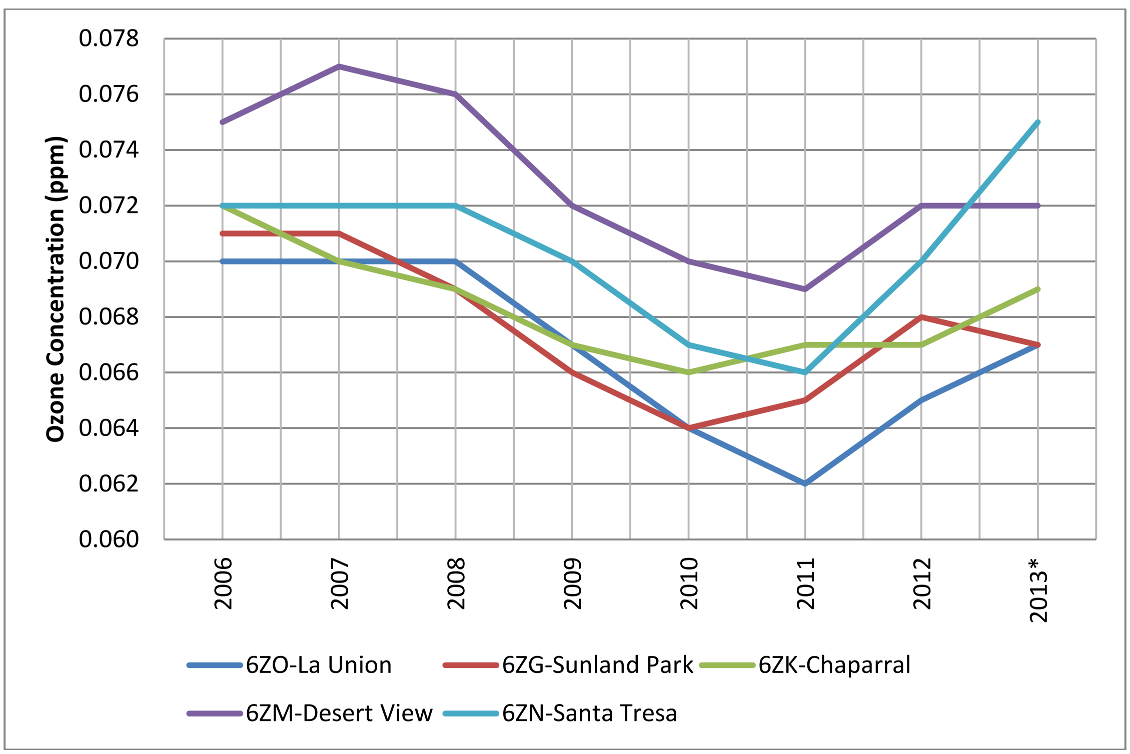


Figure 4-4: Design Values for Five Southern Doña Ana County Air Quality Monitors from 2006 through 2013 (*Note:*2013 Design values are subject to change*)

A violation of the 8-hour ozone standard occurs when the design value at any of the monitoring stations within a county above the ozone standard. For the 6ZN-Santa Teresa monitor, the 2012 and 2013 fourth highest daily maximum 8-hour average ozone concentrations (Table 4-3) were 0.077 ppm and 0.08 ppm, respectively, if the 2014 fourth highest daily maximum 8-hour average ozone concentration is greater than 0.07 ppm, the County is at risk for being in violation of the 8-hr ozone NAAQS.

4.4 Observed Annual Trend of Ozone Concentrations between January 2006 through September 2013

The daily maximum 8-hour average ozone concentration was plotted for each year beginning 2006 through 2013 to gain a better understanding of the general daily ozone concentration variations throughout the years for the five Doña Ana County and two El Paso monitors. El Paso monitors C12 and C41 were selected for comparisons between the five New Mexico monitors as these stations are located on the opposite geographic area as the NM monitors, where the Rio Grande and Franklin mountains play a role to influencing surface meteorology within this region (Li et.al. 2011).

Ozone concentrations for all of the stations were typically higher during the months of May through September. Figure 4-5 through Figure 4-12 show that more than one station experienced an elevated ozone day, or ozone peak as indicated in the figures, during the same ozone event. Regardless of the location of these monitors throughout the Paso del Norte region, the fact that the monitors all showed similar ozone concentration variation or peaks on certain days, indicates that on days with high ozone, the region as a whole was experiencing the same influence, not just certain stations within the air shed. The conceptual model developed for El Paso in 2011 showed a strong correlation between the ozone peaks or concentrations measured at the El Paso, Ciudad Juarez and southern Doña Ana County monitoring stations, indicating that all of the stations were likely "influenced by the same regional meteorology, background (or well-mixed) ozone concentrations and ubiquitous area sources" (Li et al., 2011).

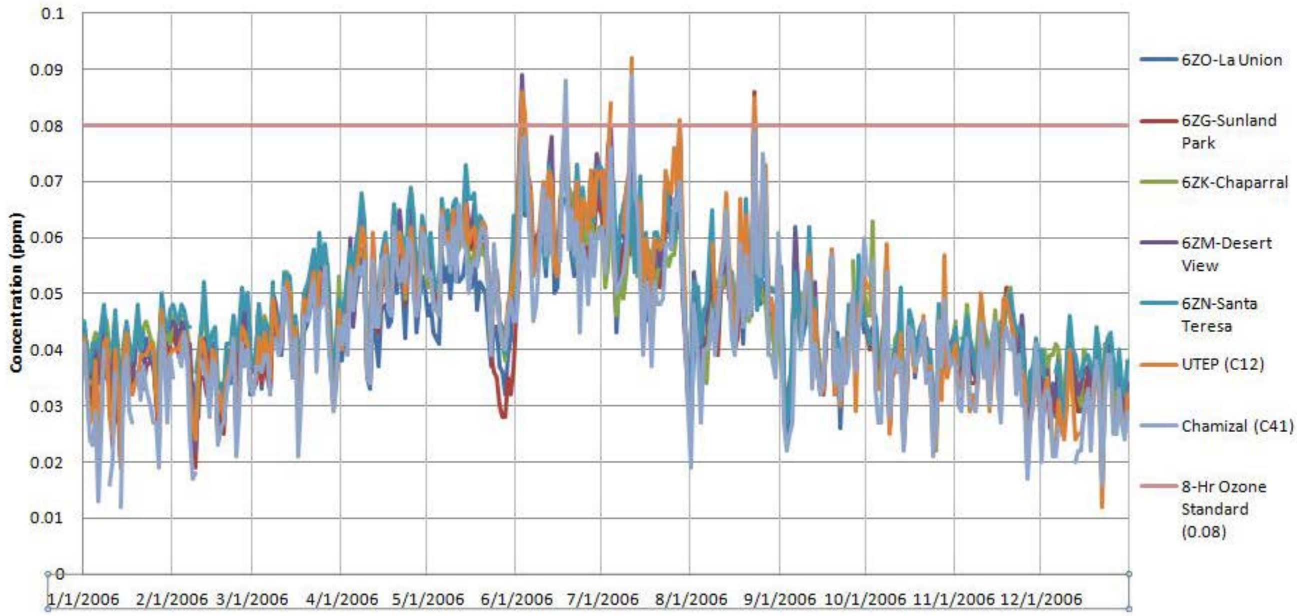


Figure 4-5: Daily Maximum 8-Hour Average Ozone Concentration January 2006 through December 2006

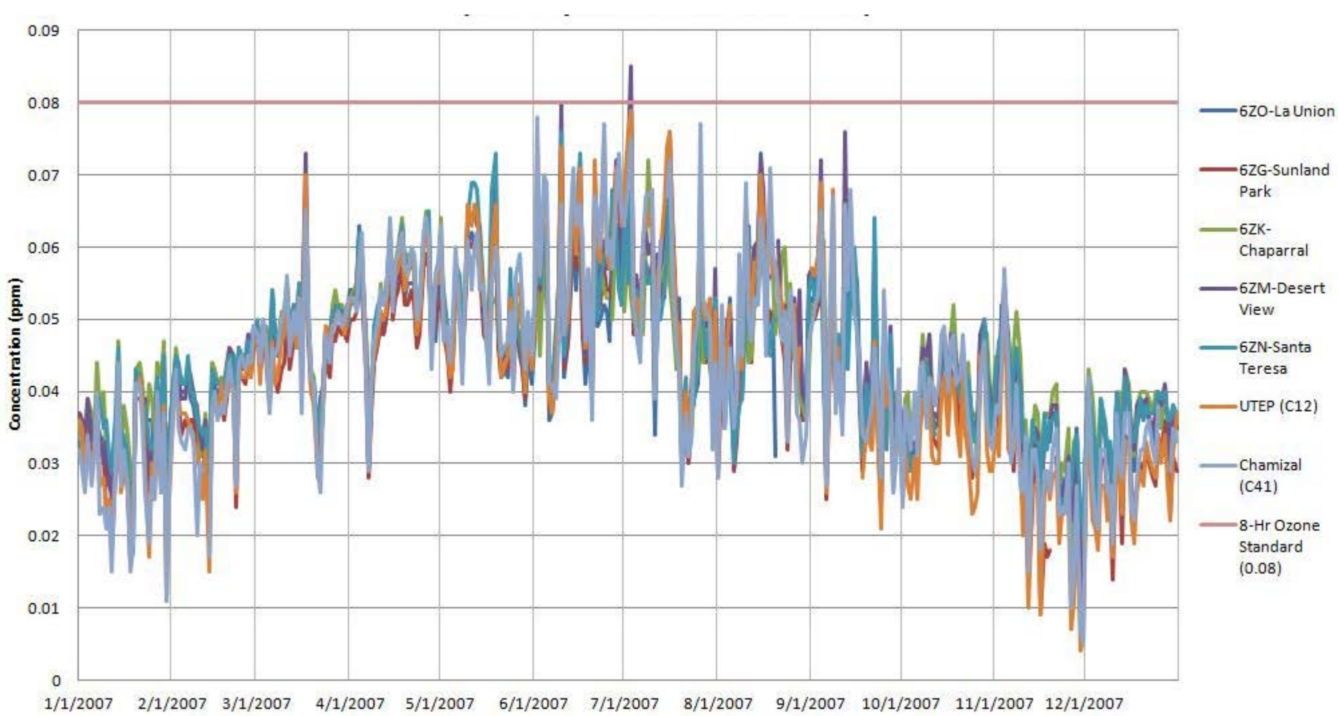


Figure 4-6: Daily Maximum 8-Hour Average Ozone Concentration January 2007 through December 2007

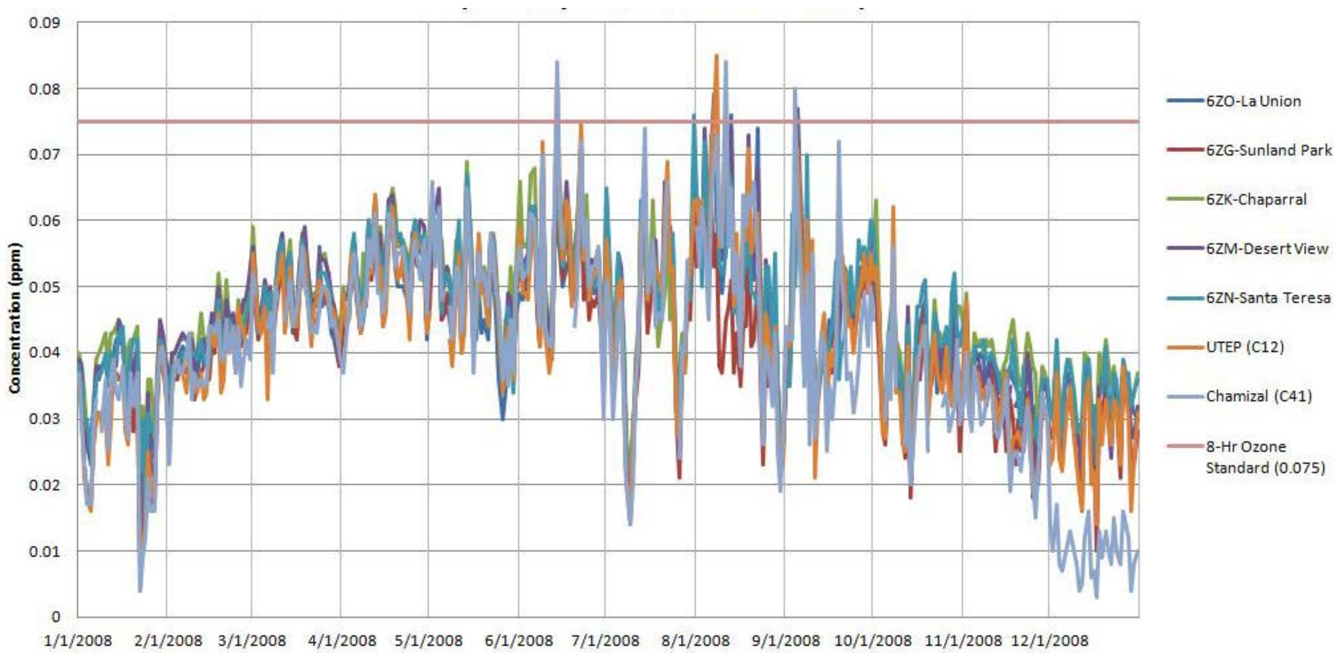


Figure 4-7: Daily Maximum 8-Hour Average Ozone Concentration January 2008 through December 2008

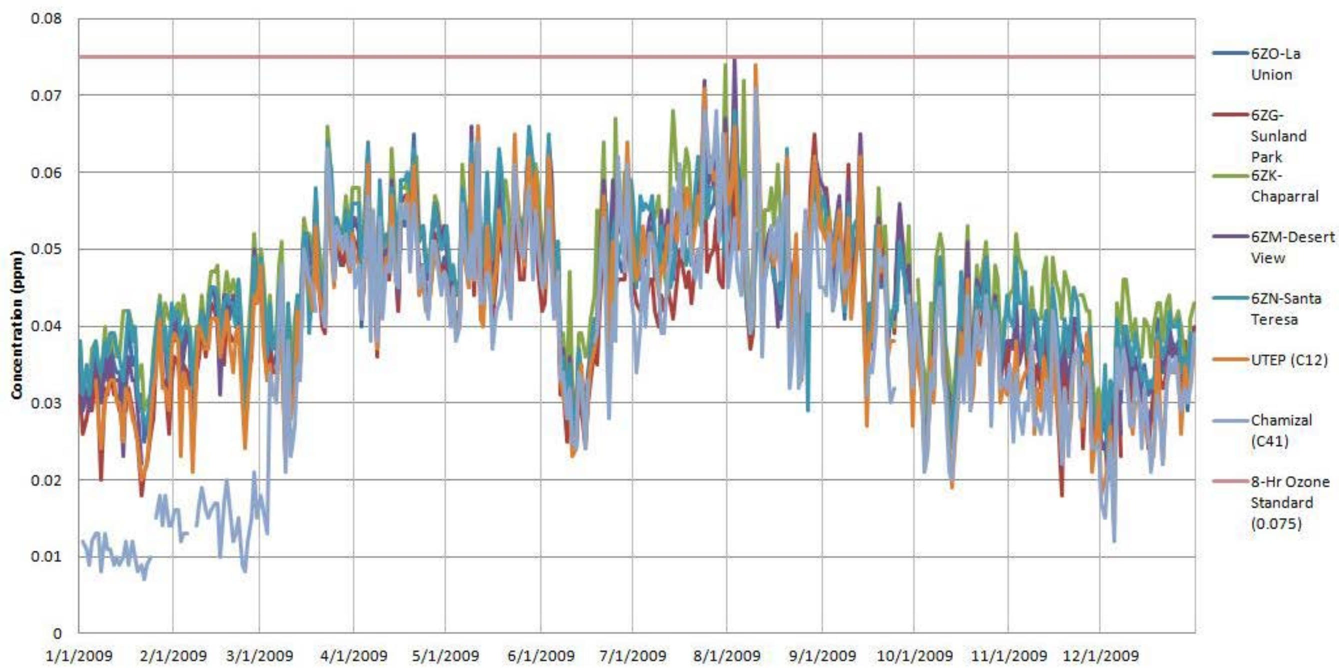


Figure 4-8: Daily Maximum 8-Hour Average Ozone Concentration January 2009 through December 2009

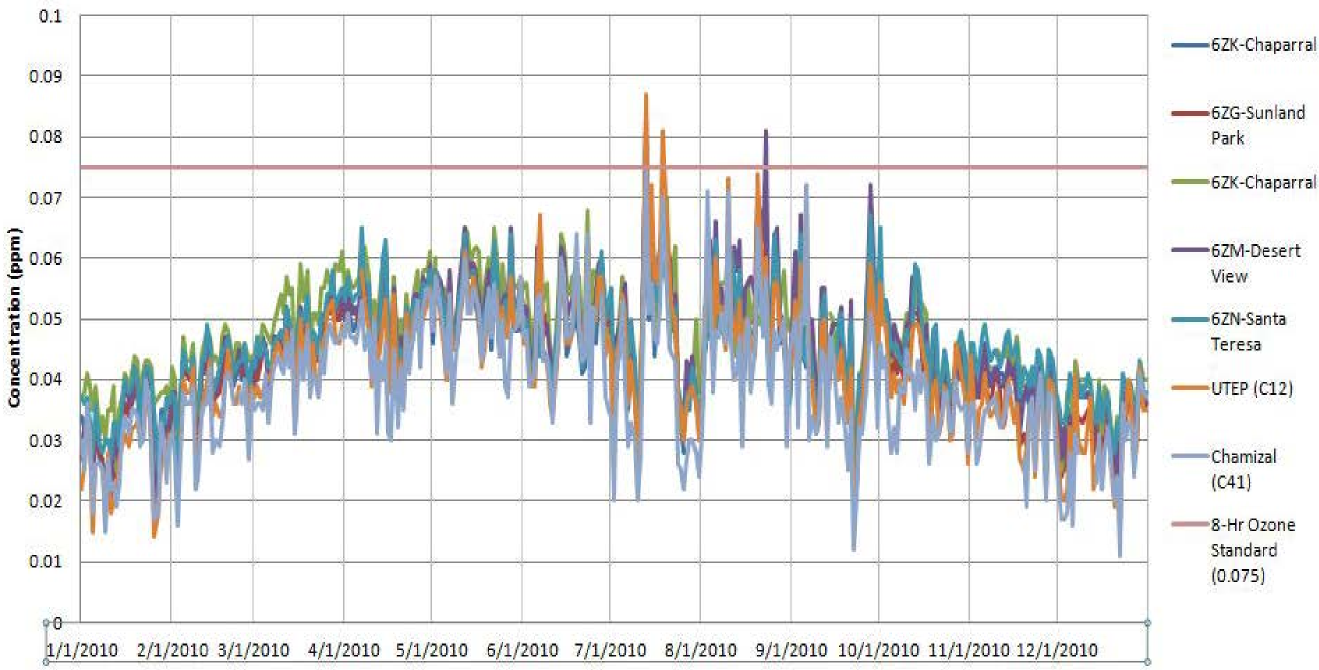


Figure 4-9: Daily Maximum 8-Hour Average Ozone Concentration January 2010 through December 2010

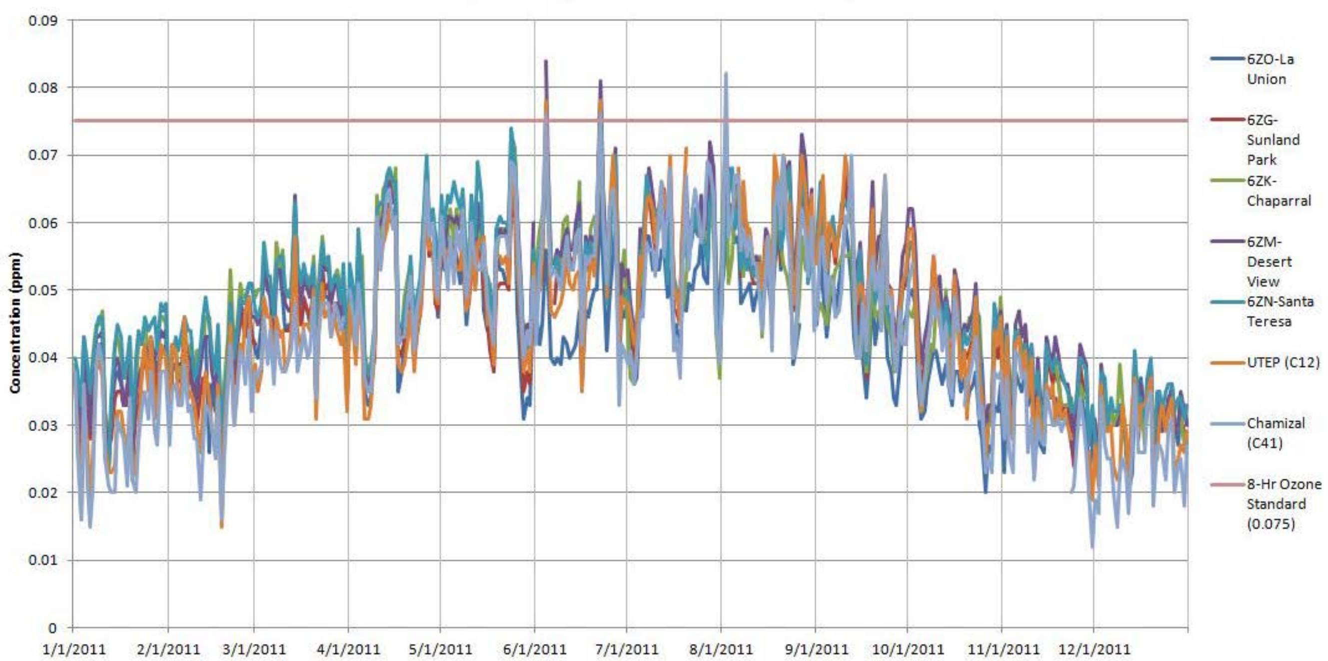


Figure 4-10: Daily Maximum 8-Hour Average Ozone Concentration January 2011 through December 2011

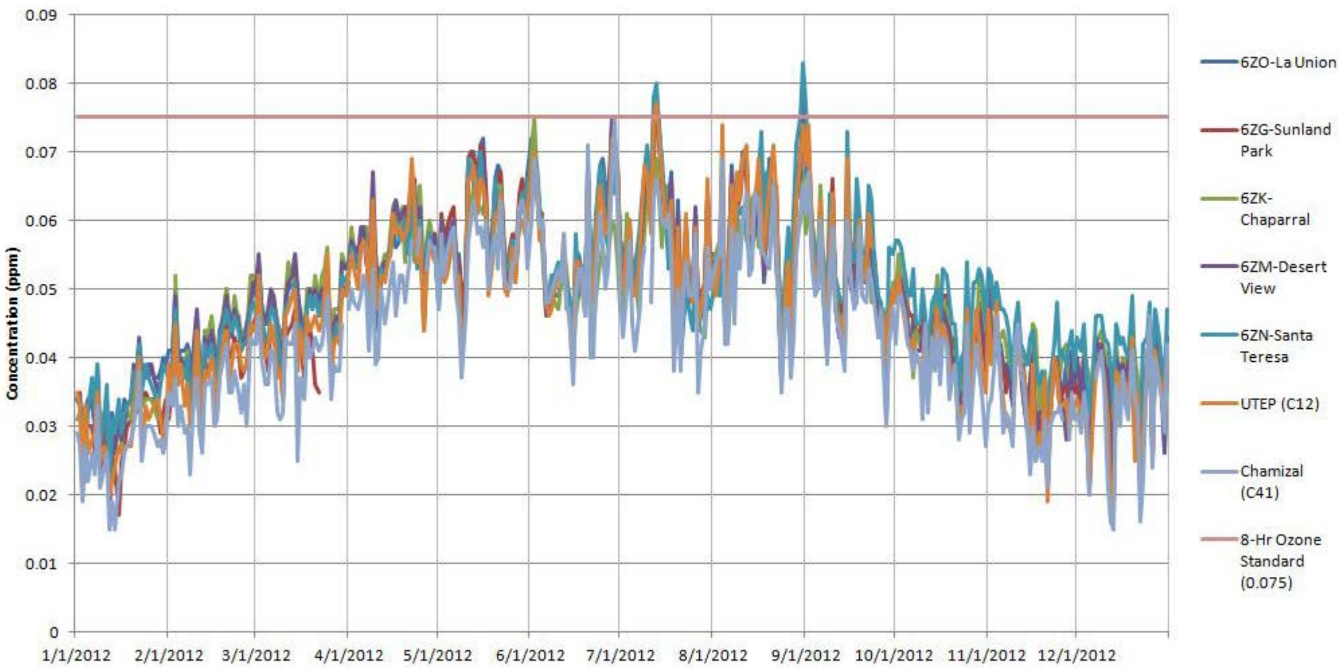


Figure 4-11: Daily Maximum 8-Hour Average Ozone Concentration January 2012 through December 2012

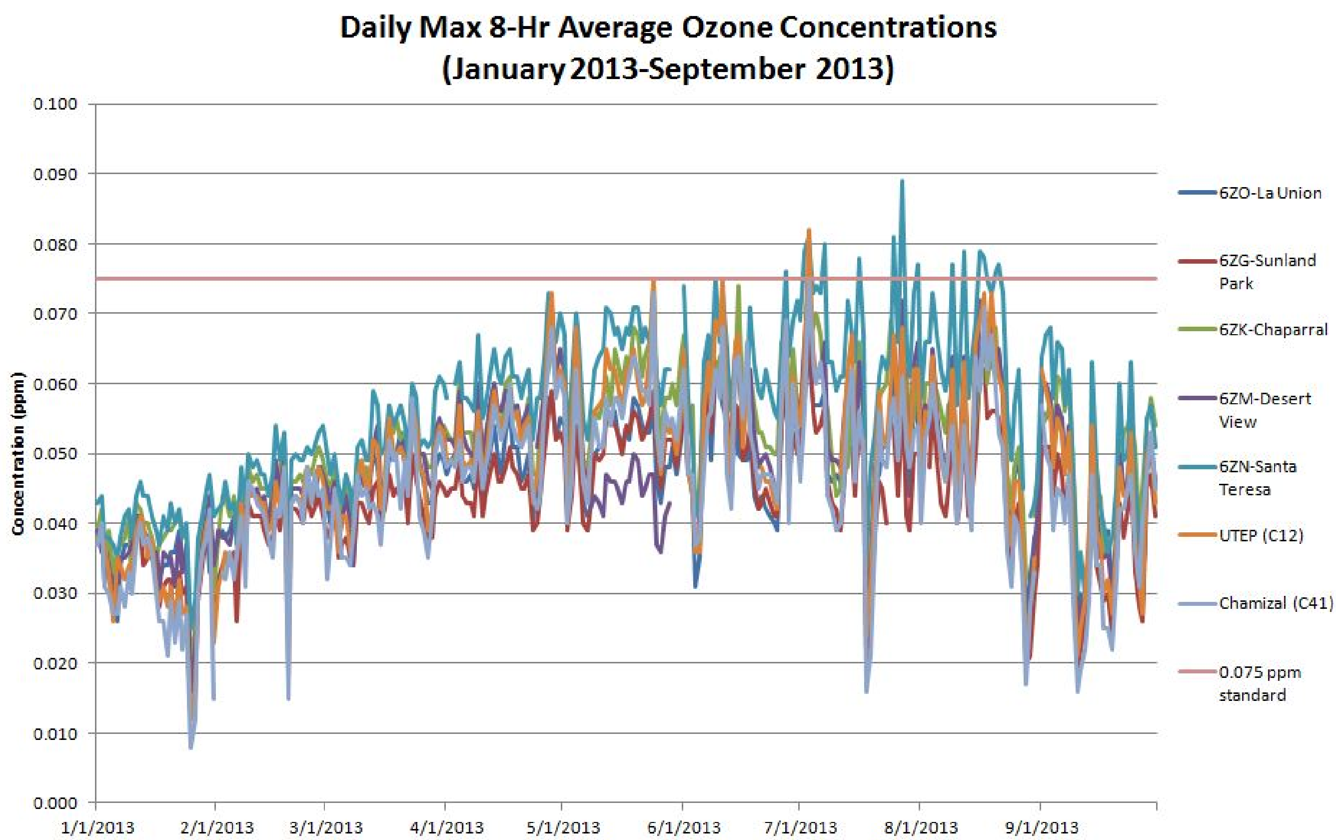


Figure 4-12: Daily Maximum 8-Hour Average Ozone Concentration January 2013 through September 2013

Comparing the highest daily maximum 8-hour average ozone concentration recorded at the stations (Figure 4-13), it is observed that between 2006 through 2009, the ozone concentration level at Desert View monitor was greater than that at other New Mexico monitors, but less than the El Paso monitors. It was, however, the highest among all seven monitors for 2010. In 2010, Sunland Park monitor recorded the highest daily maximum 8-hour average ozone concentration among the stations in New Mexico. In 2012 and 2013, the Santa Teresa monitor showed the highest daily maximum 8-hour average ozone concentrations among the seven monitors. The two most northern New Mexico monitors, Chaparral and La Union, generally showed lower daily maximum 8-hour average ozone concentration compared to the other stations.

Comparing the 4th highest daily maximum 8-hour average ozone concentrations for the seven monitors (Figure 4-14) a general downward trend is observed in all seven monitors from 2006 through 2009. For the monitors in New Mexico, Desert View exhibited the highest of the 4th highest daily maximum 8-hour average ozone concentration from 2006 through 2011, while in 2012 and 2013, the Santa Teresa monitor did. However, overall Desert View is constantly one of the top three monitors in the Paso del Norte region indicating higher ozone concentrations.

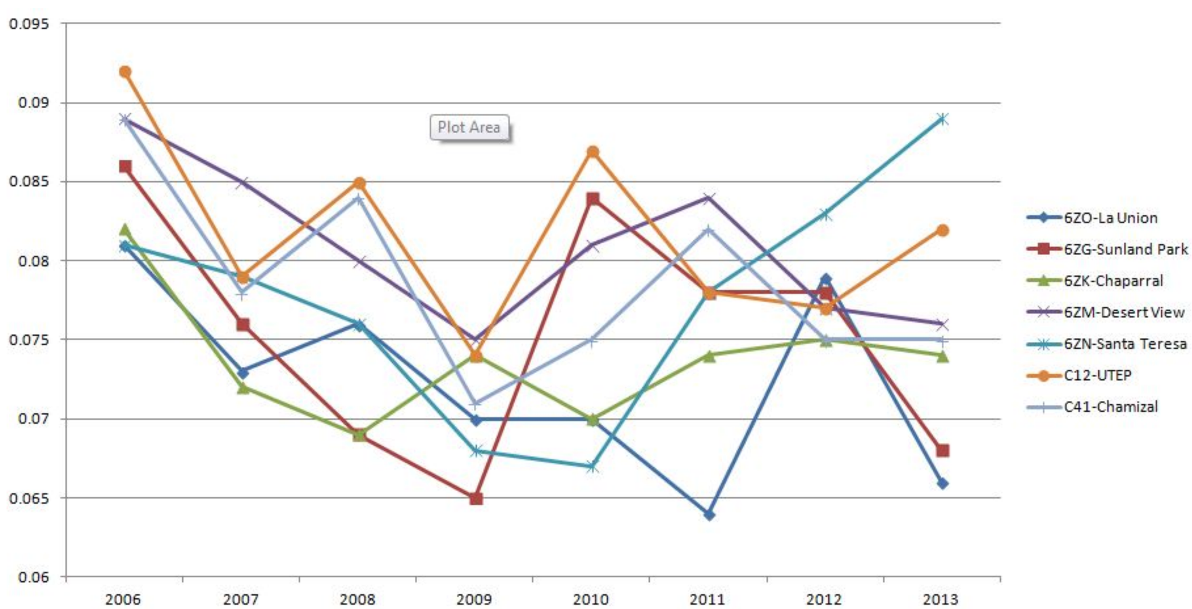


Figure 4-13: Highest Daily Maximum 8-Hour Average Ozone Concentration from 2006 through 2013 for Stations 6ZO-La Union, 6ZK-Chaparral, 6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa, C12-UTEP and C41-Chamizal

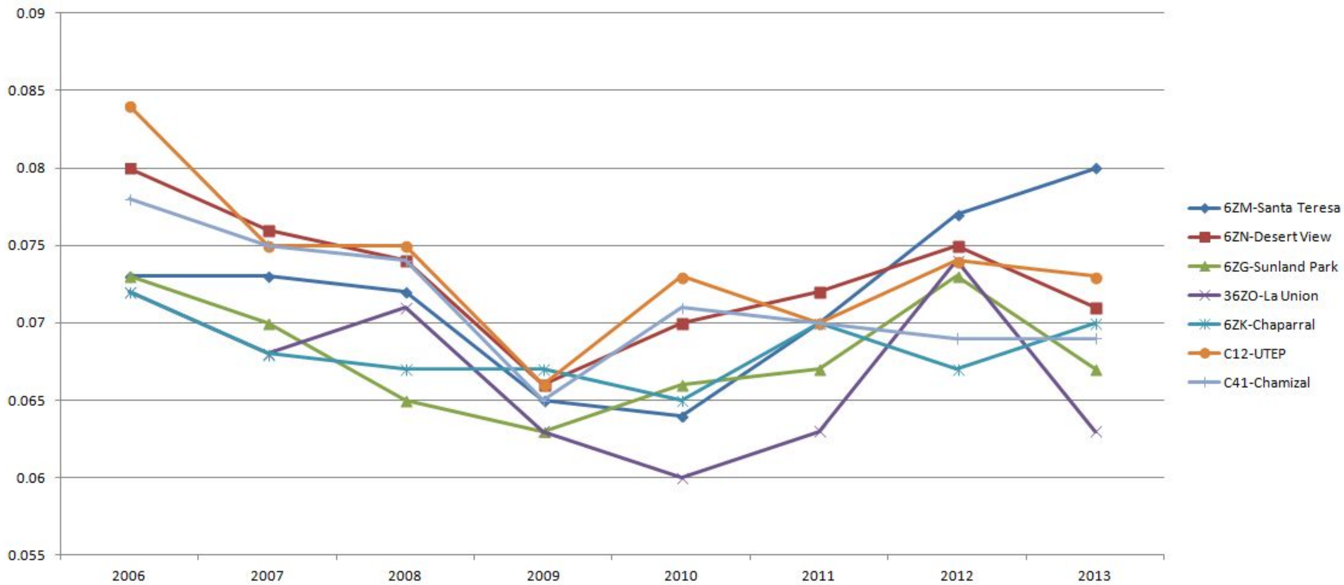


Figure 4-14: 4th Highest Daily Maximum 8-Hour Average Ozone Concentration from 2006 through 2013 for Stations 6ZO-La Union, 6ZK-Chaparral, 6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa, C12-UTEP and C41-Chamizal

Chapter 5: Surface Wind Patterns for High Ozone Days

5.1 Wind Rose and Ozone Pollution Rose Set-up

A wind and pollution rose analysis was conducted to better understand the direction of ozone transport to the study area. Wind and pollution rose plots were developed for the stations: 6ZM-Santa Teresa (ST), 6ZM-Desert View (DV), 6ZG-Sunland Park (SP), and C12-UTEP (UT). The C12-UTEP monitor was chosen to compare wind patterns located on the opposite side of the mountain range, Mount Cristo, from the New Mexico monitors. The wind and pollution rose plots were developed using hourly data (i.e. resultant wind speed (m/s), resultant wind direction (degrees) and maximum ozone concentration) for the years from 2006 through 2013. The plots were specifically for the ozone seasons (May through September) of each year. In addition, the plots created focused on the high ozone days for the hours of 10 A.M. to 6 P.M., only. High ozone days are defined days where the daily maximum 8-hour average ozone concentration was greater than 0.06 ppm (60 ppb). The 8-hour time period was chosen as it represents the period of the day when ozone concentrations reach their maximum.

Table 5-1 lists the number of high ozone days used for each of the stations for each individual year. The tables for specific days that were flagged as high ozone days, for each of the stations per year, are included in Appendix B. The wind roses generated utilized 16 wind direction sectors (22.5 degrees each section) with six wind speed categories (0.5 - 2.1 m/s; 2.1 - 3.6 m/s; 3.6 - 5.7 m/s; 5.8 - 8.8 m/s; 8.8 – 11.1 m/s; > 11.1 m/s). The pollution rose generated, where ozone concentration is substituted for wind speed, was divided into six concentration categories (0-40 ppb; 40-50 ppb; 50-60 ppb; 60-70 ppb; 70-75 ppb; > 75ppb).

Table 5.1 Number of High Ozone Days (> 0.06 ppm) used for Wind Rose and Ozone Pollution Analysis for Each Station per Year

	6ZN-Santa Teresa	6ZM–Desert View	6ZG-Sunland Park	C12-UTEP
2006	58	52	22	55
2007	23	33	21	35
2008	24	27	10	25
2009	13	16	5	15
2010	11	22	16	13
2011	45	49	35	36
2012	55	52	56	53
2013	94	32	7	40

5.2 Wind Rose and Pollution Rose Analysis

The following sections present both the wind and pollution roses for the monitoring stations 6ZG-Sunland Park, 6ZM-Desert View, 6ZM-Santa Teresa and C12-UTEP for years 2006, 2012 and 2013 only, with years 2007 through 2011 included in Appendix C for reference to avoid repetitive presentation of similar data. However, observations of wind and ozone pollution roses for all years and for the four stations are discussed in this chapter. The three years are selected for presentation in this section because two of the three years represented the most recent ozone seasons and 2006 represented an ozone season with as many high ozone days relative to 2012 and 2013.

5.2.1 Santa Teresa - Wind Rose and Ozone Pollution Rose: 2006 to 2013 (10 A.M. – 6 P.M.)

The wind rose (Figure 5-1) for 2006 through 2013 for the Santa Teresa monitoring station, showed that 28% of the time, the prevailing area winds were from the east southeastern (ESE) direction, followed by east (E) winds (13% of the time), southeast (SE) and west (W) winds (both wind directions at 8% of the time). Overall, winds speeds blew 19% of the time from 0.5 to 2.1 m/s, 39% from 2.1 to 3.6 m/s, 29% from 3.6 to 5.7 m/s, 11% from 5.7 to 8.8 m/s and 1% greater than 8.8 m/s. Examining

wind speeds from the ESE direction, approximately 14% of the time winds blew at relatively light to moderate speeds between 3.6 to 5.7 m/s, followed by 9% at relatively low wind speeds between 2.1 to 3.6 m/s. East (E) winds blew at wind speeds between 2.1 to 3.6 m/s (6% of the time), followed by wind speeds between 3.6 to 5.7 m/s (5% of the time). Southeast wind speeds blew between 2.1 to 3.6 m/s (4% of the time) and 3.6 to 5.7 m/s (2% of the time). West wind speeds blew at 2% and 1%, for wind speeds between 3.6 to 5.7 m/s and 2.1 to 3.6 m/s, respectively. Table 5-2 presents the wind rose statistics for the Santa Teresa monitoring station from 2006 to 2013.

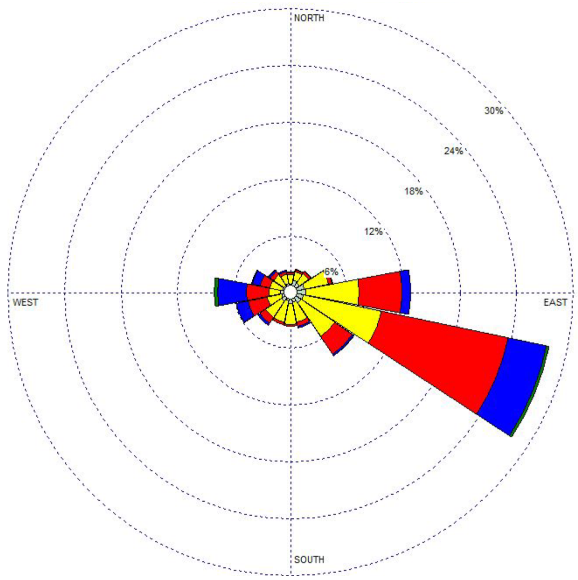


Figure 5-1: Wind Rose for Santa Teresa Monitoring Station from 2006 through 2013

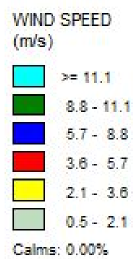


Table 5-2: Percentage of Frequency Distribution of Wind Direction and Wind Speed at Santa Teresa Monitoring Station from 2006 through 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	Total
N	0.9	1.0	0.2	0.0	0.0	0.0	2.1
NNE	1.3	1.0	0.2	0.0	0.0	0.0	2.5
NE	1.2	1.2	0.3	0.1	0.0	0.0	2.8
ENE	1.5	2.6	0.4	0.1	0.0	0.0	4.6
E	1.7	5.6	4.5	0.9	0.1	0.0	12.8
ESE	1.4	8.4	13.7	4.2	0.2	0.0	28.0
SE	1.4	4.3	2.3	0.2	0.0	0.0	8.2
SSE	1.1	2.1	0.4	0.2	0.0	0.0	3.9
S	1.3	2.2	0.2	0.0	0.0	0.0	3.7
SSW	1.0	2.3	0.2	0.0	0.0	0.0	3.5
SW	1.2	2.0	0.8	0.3	0.0	0.0	4.3
WSW	1.0	1.6	2.0	1.2	0.0	0.0	5.9
W	1.1	1.2	2.4	3.1	0.4	0.0	8.2
WNW	0.9	1.4	1.0	0.9	0.1	0.0	4.3
NW	0.9	1.3	0.4	0.2	0.0	0.0	2.9
NNW	1.0	1.0	0.3	0.1	0.0	0.0	2.4
Sub-Total	19.0	39.3	29.4	11.4	0.9	0.1	100.0
Calms							0
Missing/Incomplete							0

The wind rose plots for 2006 (Figure 5-2), 2012 (Figure 5-3) and 2013 (Figure 5-4) showed that prevailing winds were from ESE wind direction; however, winds from the E and SE directions were also significant. The ESE winds blew at wind speeds (between 3.6 to 5.7 m/s) occurring at 12% (Year 2006), 18% (Year 2012), and 14% (Year 2013) of time. These light-moderate wind speed conditions (NOAA SPC, 2014) could potentially contribute to more of scattering or dispersion effect of ozone precursors or concentration in the area. The second highest dominate wind speed within the ESE direction, were the lighter wind conditions (2.1 m/s to 3.6 m/s), occurring 9% (Year 2006), 11% (Year 2012) and 5% (Year 2013) of the time. In addition, for 2006 and 2013 ozone season, the station experienced slightly more frequent winds coming from the west (W), west-southwest (WSW) and southwest (SW) directions. Summary tables of the wind statistics for the Santa Teresa monitoring station from 2006 to 2013 are included in Appendix D.

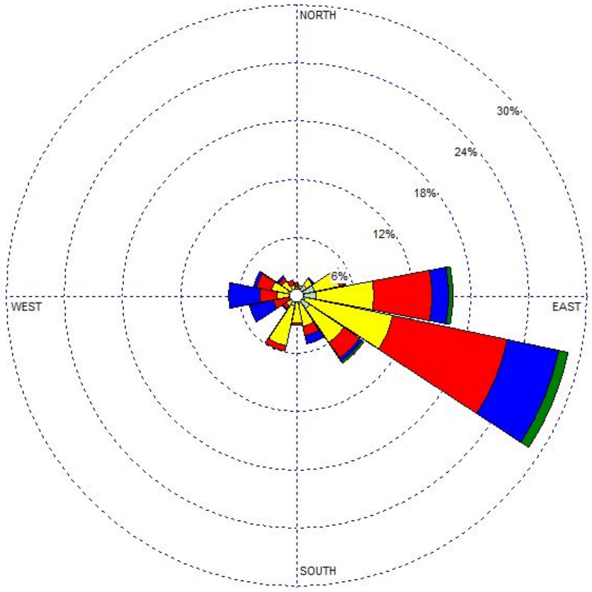


Figure 5-2: 2006 Wind Rose ST

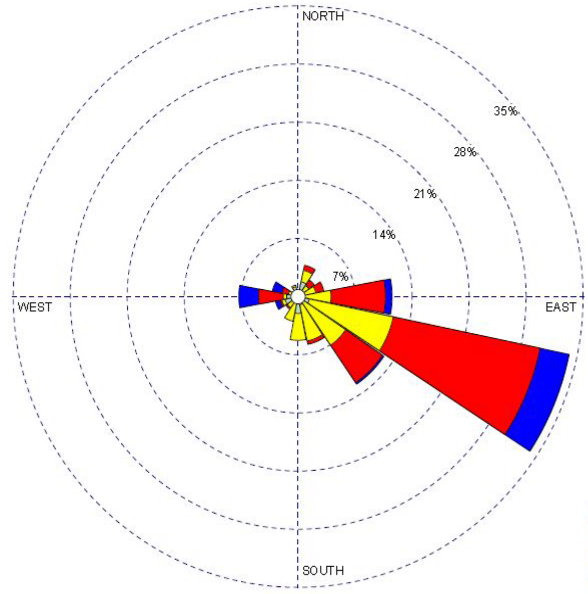


Figure 5-3: 2012 Wind Rose ST

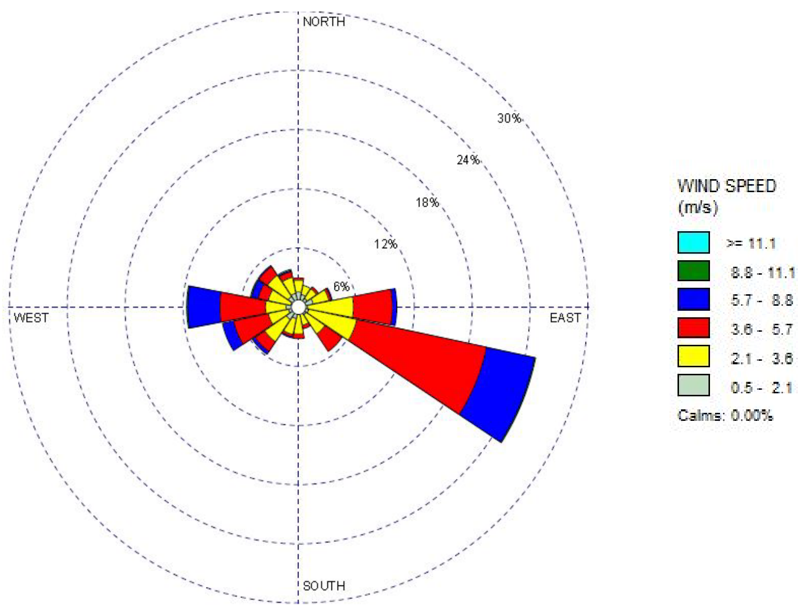


Figure 5-4: 2013 Wind Rose ST

The ozone pollution rose (Figure 5-5) is expected to be visually similar to the wind rose for 2006 through 2013, in such a way that the prevailing direction for the majority of ozone arriving to the station will be in the same prevailing direction that was observed in the wind rose. The majority of ozone

arriving at the station for the eight years were from ESE direction, followed by east (E), southeast (SE) and west (W) directions (Table 5-3). Winds for the 8 years blew approximately 1% of the time between 0 to 40 ppb, 4% at 40 to 50 ppb, 19% at 50 to 60 ppb, 49% at 60 to 70 ppb, 13% at 70 to 75 ppb and 10% at concentrations greater than 75 ppb (Table 5-3). East-southeast (ESE) winds blew 3% of the time at ozone concentrations greater than 75 ppb, followed by E and SE winds at 1.6% and 1.4%, respectively (Table 5-3).

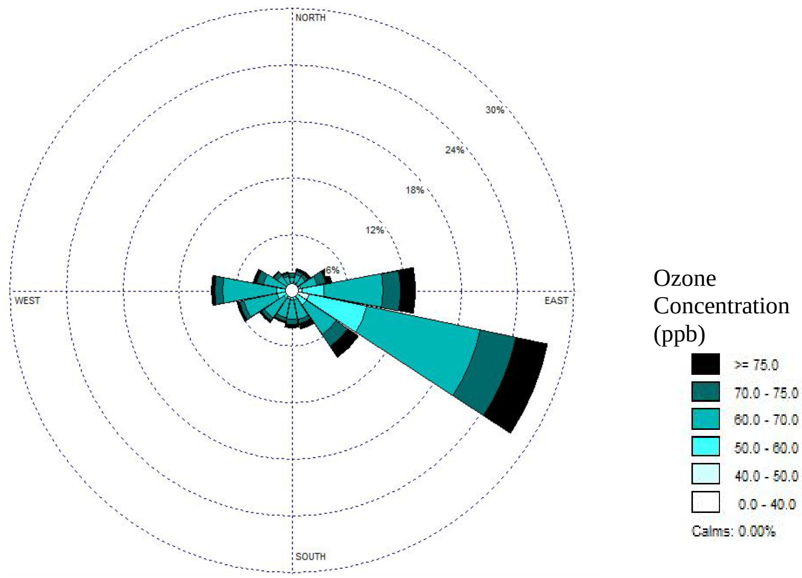


Figure 5-5: Ozone Pollution Rose for Santa Teresa Monitoring Station from 2006 through 2013

Table 5-3: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration at Santa Teresa Monitoring Station from 2006 through 2013

Directions / Ozone Concentration (ppb)	0.0 - 40.0	40.0 - 50.0	50.0 - 60.0	60.0 - 70.0	70.0 - 75.0	>= 75.0	Total
N	0.0	0.1	0.5	0.8	0.4	0.0	1.9
NNE	0.0	0.2	0.7	0.9	0.4	0.3	2.3
NE	0.1	0.1	0.5	1.2	0.4	0.3	2.4
ENE	0.1	0.2	0.8	1.7	1.0	0.6	4.2
E	0.5	0.6	2.4	6.3	1.8	1.6	12.7
ESE	0.4	1.5	6.2	12.2	3.9	3.4	27.0
SE	0.0	0.6	1.3	3.8	1.5	1.4	8.4
SSE	0.0	0.3	0.8	2.1	0.5	0.6	4.1
S	0.0	0.1	0.9	2.0	0.6	0.4	3.9
SSW	0.1	0.2	0.7	2.0	0.4	0.2	3.4
SW	0.1	0.0	0.9	2.5	0.4	0.2	4.1
WSW	0.0	0.4	1.3	3.6	0.5	0.3	5.9
W	0.0	0.2	1.5	5.7	0.8	0.4	8.4
WNW	0.0	0.1	0.3	2.7	0.7	0.4	4.1
NW	0.0	0.1	0.6	1.3	0.5	0.2	2.5
NNW	0.0	0.0	0.3	1.3	0.3	0.2	2.0
Sub-Total	1.4	4.4	19.1	48.7	13.4	10.2	97.3
Calms							0.0
Missing/Incomplete							2.7

Overall, for the years 2006 (Figure 5-6), 2012 (Figure 5-7) and 2013 (Figure 5-8), the Santa Teresa monitoring station observed the poorest air quality (ozone concentrations > 75 ppb) when winds were from the east-southeast (ESE) direction. For 2006, the majority of ozone concentrations greater than 75ppb were observed when the winds were from east-southeast (ESE) direction and southeast (SE) direction at 4% and 2%, respectively. Ozone concentrations (>75ppb) were also observed when winds blew from the NE, ENE, E, SSE, S, SSW, W and WNW directions. For 2012, the majority of ozone concentrations (>75ppb) were observed when winds blew from ESE direction at 7%. Ozone concentrations (>75 ppb) were also observed in winds blowing from various other wind directions (NNE, ENE, E, SE, S, WSW, W and WNW). For 2013, ozone concentrations (>75ppb) were observed when winds blew from the ESE and east (E) directions at approximately 3% and 2% of the time, respectively. Summary tables of the ozone pollution rose statistics for the Santa Teresa monitoring station from 2006, 2012 and 2013 have been included in Appendix D.

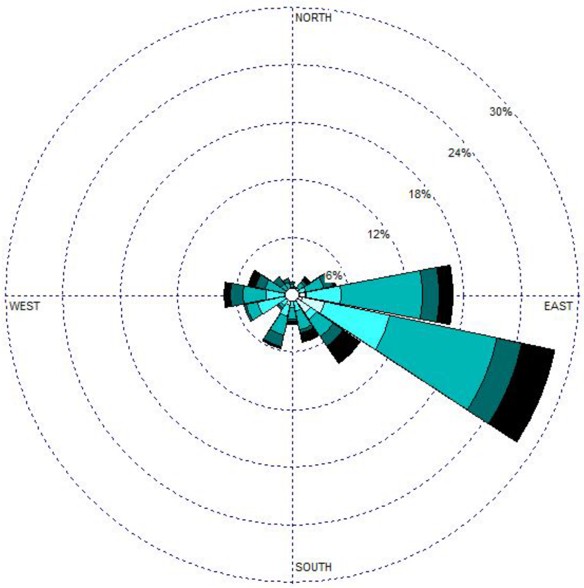


Figure 5-6: 2006 Ozone Pollution Rose ST

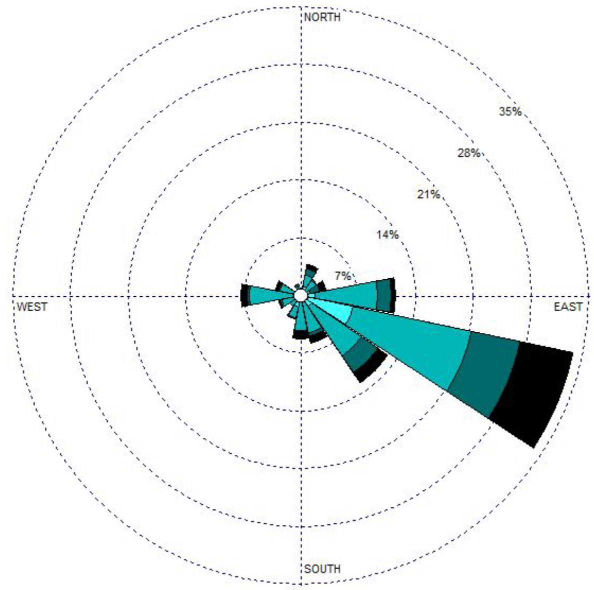


Figure 5-7: 2012 Ozone Pollution Rose ST

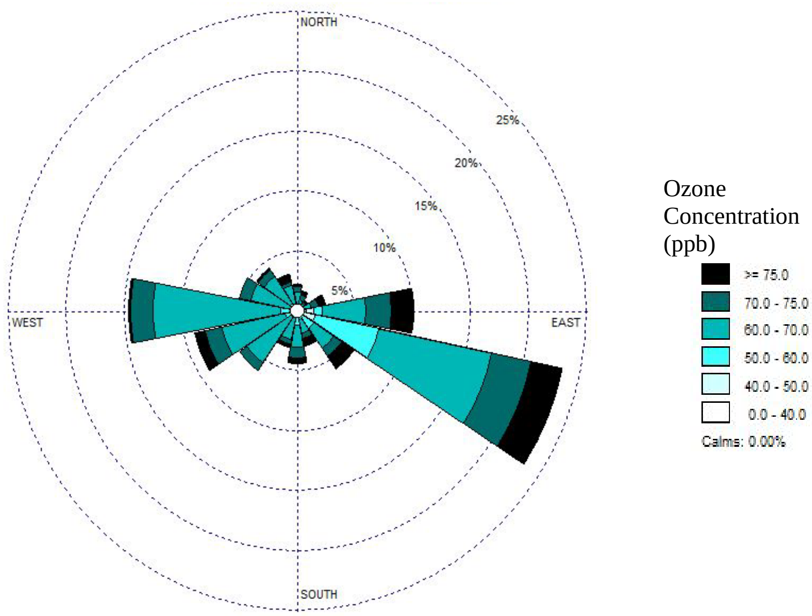


Figure 5-8: 2013 Ozone Pollution Rose ST

5.2.2 Desert View - Wind Rose and Ozone Pollution Rose: 2006 to 2013 (10 A.M. – 6 P.M.)

The wind rose (Figure 5-9) for the Desert View monitoring station from 2006 to 2013, showed that prevailing area winds were from the east southeastern (ESE) direction (24% of the time), followed by southeast (SE) winds (16% of the time) and east (E) winds at (10% of the time). Overall, 33% of

wind speeds present were from 0.5 to 2.1 m/s, 45% from 2.1 to 3.6 m/s, 18% from 3.6 to 5.7 m/s and 3% from 5.7 to 8.8 m/s; no wind speeds greater than 8.8 m/s was observed at this station. Examining winds from the ESE direction, winds blew at relatively low wind speeds between 2.1 to 3.6 m/s (13% of the time), followed by wind speeds between 3.6 to 5.7 m/s (7% of the time). Winds from the SE blew at winds speeds between 2.1 to 3.6 m/s (9% of the time), followed by wind speeds between 0.5 – 2.1 m/s (4% of the time). East wind speeds blew between 2.1 to 3.6 m/s (5% of the time) and 0.5 – 2.1 m/s (3% of the time). Table 5-4 presents the wind rose statistics for the Desert View monitoring station from 2006 to 2013.

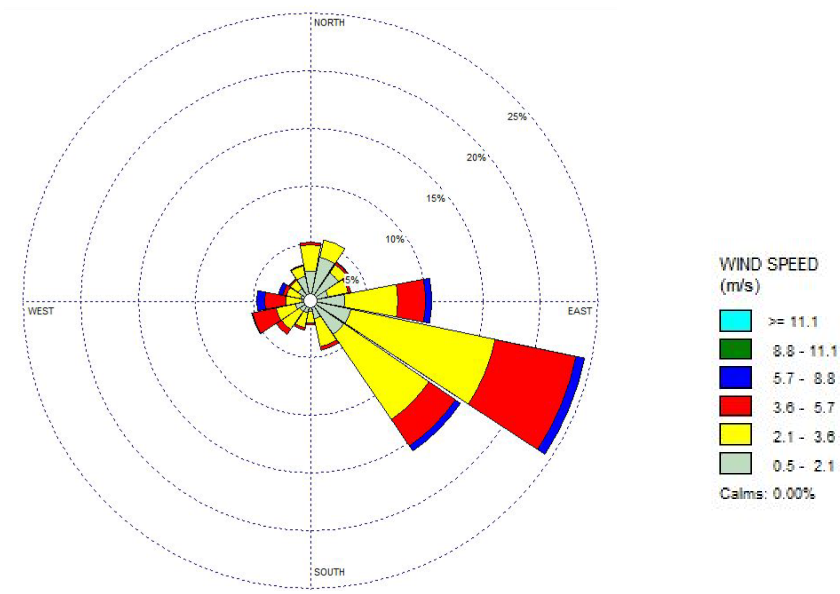


Figure 5-9: Wind Rose for Desert View Monitoring Station from 2006 through 2013

Table 5-4: Percentage of Frequency Distribution of Wind Direction and Wind Speed at Desert View Monitoring Station from 2006 through 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	Total
N	2.6	2.3	0.2	0.0	0.0	0.0	5.0
NNE	3.9	1.6	0.0	0.0	0.0	0.0	5.4
NE	3.0	0.9	0.2	0.1	0.0	0.0	4.1
ENE	1.6	1.8	0.2	0.0	0.0	0.0	3.6
E	3.0	4.7	2.4	0.5	0.0	0.0	10.4
ESE	3.6	12.8	7.1	0.8	0.0	0.0	24.2
SE	3.6	8.9	2.8	0.5	0.0	0.0	15.7
SSE	1.6	2.5	0.3	0.0	0.0	0.0	4.4
S	1.0	1.0	0.1	0.0	0.0	0.0	2.1
SSW	1.1	1.3	0.2	0.0	0.0	0.0	2.6
SW	1.2	1.9	0.5	0.0	0.0	0.0	3.6
WSW	1.4	1.7	2.1	0.1	0.0	0.0	5.2
W	0.7	1.4	1.8	0.7	0.0	0.0	4.7
WNW	0.9	1.2	0.4	0.4	0.0	0.0	2.8
NW	1.4	0.8	0.1	0.0	0.0	0.0	2.3
NNW	2.2	0.9	0.1	0.0	0.0	0.0	3.2
Sub-Total	32.5	45.4	18.4	3.1	0.0	0.0	99.5
Calms							0.0
Missing/Incomplete							0.5

Similar to the Santa Teresa monitoring station, the wind rose plots for the Desert View monitoring station, showed that for 2006 (Figure 5-10), 2012 (Figure 5-11) and 2013 (Figure 5-12), the prevailing wind direction was from ESE direction, at 24%, 34% and 24% of the time, respectively. However, unlike the Santa Teresa station, the dominate wind speeds from the ESE direction blew at the lower wind speeds between 2.1 – 3.6 m/s occurring at 12% (Year 2006), 18% (Year 2012), and 13% (Year 2013) of time. The second highest dominate wind speed within the ESE direction, were the more moderate wind conditions (3.6 m/s to 5.7 m/s), occurring 6% (Year 2006), 13% (Year 2012) and 8% (Year 2013) of the time. In 2013, compared to 2006 and 2012, the station experienced slightly higher frequent winds coming from the east-northeast (ENE), northeast (NE) and north-northeast (NNE) directions. For 2006 only, the frequency of SE winds was very similar to frequency of wind experienced from the ESE direction. Summary tables of the wind statistics for the Desert View monitoring station for the years 2006, 2012 and 2013 have been included in Appendix D.

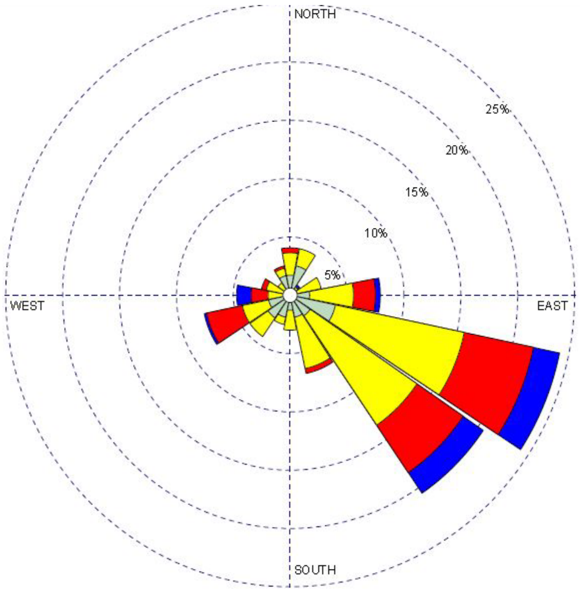


Figure 5-10: 2006 Wind Rose DV

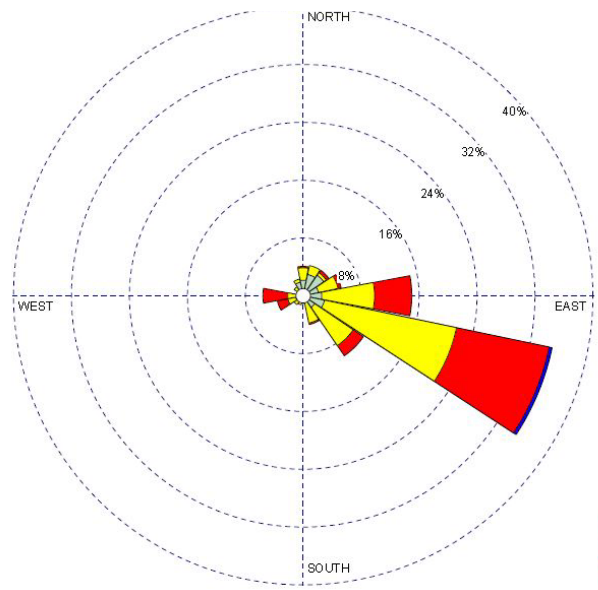


Figure 5-11: 2012 Wind Rose DV

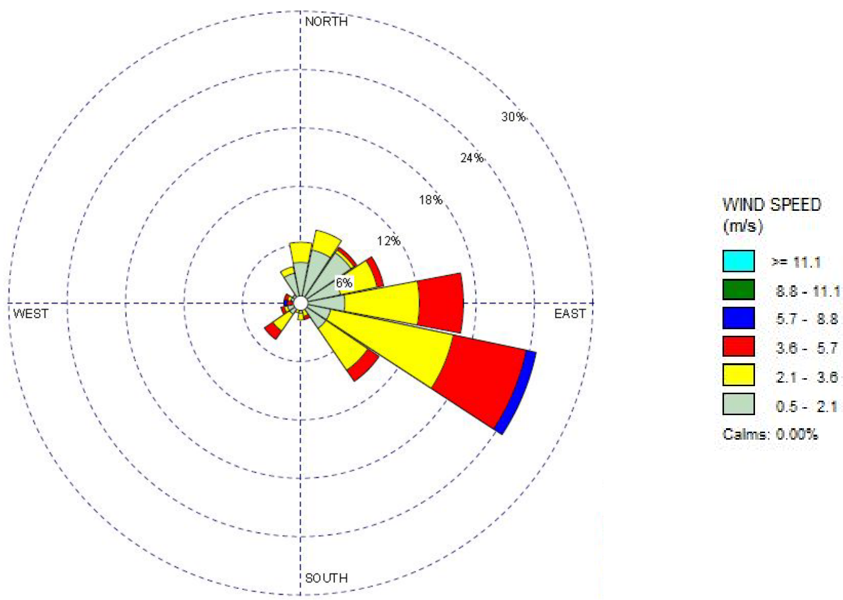


Figure 5-12: 2013 Wind Rose DV

The ozone pollution rose (Figure 5-13) from 2006 to 2013, showed that the majority of ozone concentrations arriving at the Desert View monitoring station for the eight years was from ESE direction, followed by southeast (SE) and east (E) direction (Table 5-5). The winds for the 8 years blew approximately 1% of the time between 0 to 40 ppb, 6% at 40 to 50 ppb, and 19% at 50 to 60 ppb, 45% at

60 to 70 ppb, 12% at 70 to 75 ppb and 15% at concentrations greater than 75 ppb (Table 5-5). Winds from both the ESE and SE directions blew 3% of the time at ozone concentrations greater than 75 ppb (Table 5-5).

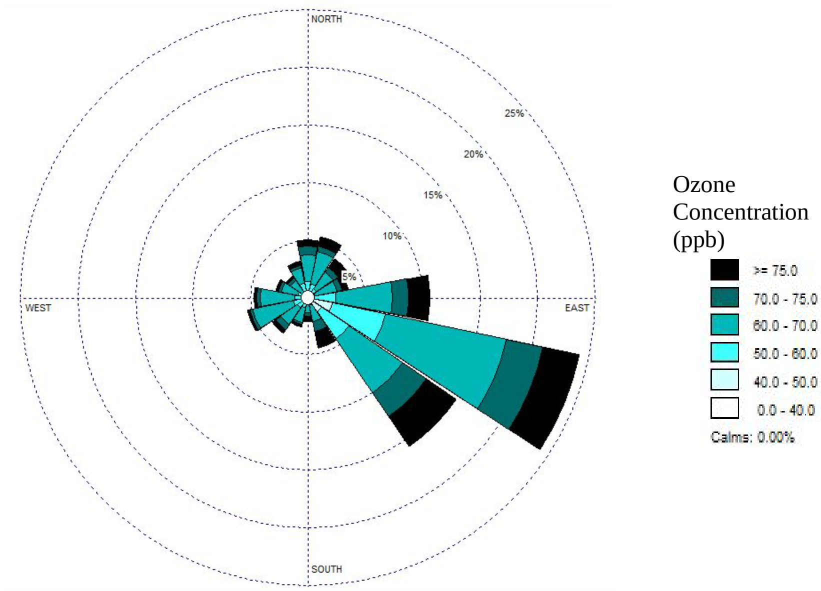


Figure 5-13: Ozone Pollution Rose for Desert View Monitoring Station from 2006 through 2013

Table 5-5: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration at Desert View Monitoring Station from 2006 through 2013

Directions / Ozone Concentration (ppb)	0.0 - 40.0	40.0 - 50.0	50.0 - 60.0	60.0 - 70.0	70.0 - 75.0	>= 75.0	
N	0.1	0.3	1.0	2.3	0.8	0.5	4.9
NNE	0.0	0.3	1.0	2.8	0.5	0.9	5.3
NE	0.0	0.3	0.6	1.8	0.5	0.9	4.0
ENE	0.0	0.0	0.7	1.9	0.5	0.5	3.5
E	0.0	0.4	2.1	5.0	1.4	1.8	10.4
ESE	0.3	1.9	4.7	10.7	3.2	3.3	23.6
SE	0.3	1.2	2.9	5.7	2.4	3.1	15.3
SSE	0.0	0.2	0.5	1.5	0.9	1.4	4.4
S	0.0	0.2	0.4	0.8	0.3	0.5	2.1
SSW	0.0	0.2	0.7	1.4	0.1	0.2	2.6
SW	0.0	0.1	1.0	1.8	0.5	0.4	3.7
WSW	0.0	0.2	1.1	3.6	0.3	0.2	5.2
W	0.0	0.2	0.9	3.1	0.3	0.2	4.6
WNW	0.0	0.1	0.8	1.5	0.2	0.3	2.8
NW	0.0	0.1	0.4	1.4	0.3	0.2	2.3
NNW	0.0	0.3	1.0	1.4	0.2	0.3	3.2
Sub-Total	0.9	5.9	19.3	45.3	12.0	14.5	97.9
Calms							0.0
Missing/Incomplete							2.1

The Desert View monitoring station observed the poorest air quality (ozone concentrations > 75 ppb) when the prevailing winds were from the east-southeast (ESE) and southeast (SE) for 2006 (Figure 5-14) and 2012 (Figure 5-15). However, for 2013 (Figure 5-16), ozone concentrations (>75 ppb) were equally distributed for several directions (N, NE, E, ESE and SE). For 2006, 5% of the time winds from the east-southeast (ESE) and southeast (SE) directions blew at ozone concentrations greater than 75ppb. Ozone concentrations (>75ppb) were also observed when wind speeds blew from other wind directions. For 2012, 3% of the time, ozone concentrations (>75ppb) were observed when winds blew from both the ESE direction and SE direction. For 2013, the ozone concentrations (>75ppb) arrived from the northeast (NE) direction at a 2% of the time; ozone concentrations (>75 ppb) were also observed when winds blew from several other directions. Summary tables of the ozone pollution rose statistics from 2006, 2012 and 2013 for the Desert View monitoring station have been included in Appendix D.

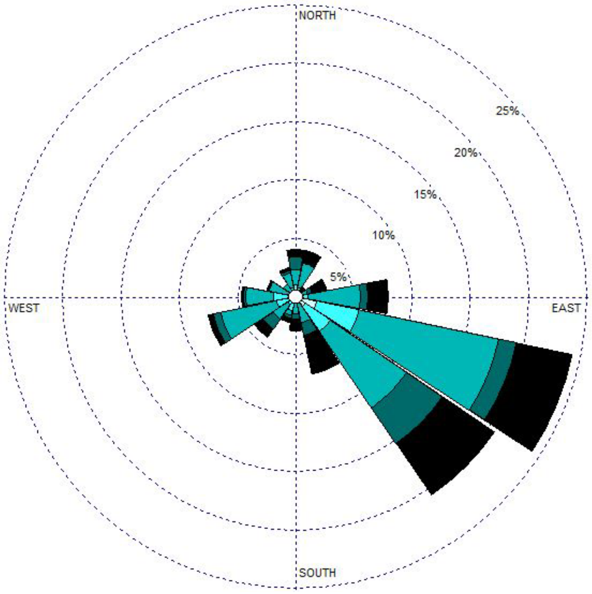


Figure 5-14: 2006 Ozone Pollution Rose DV

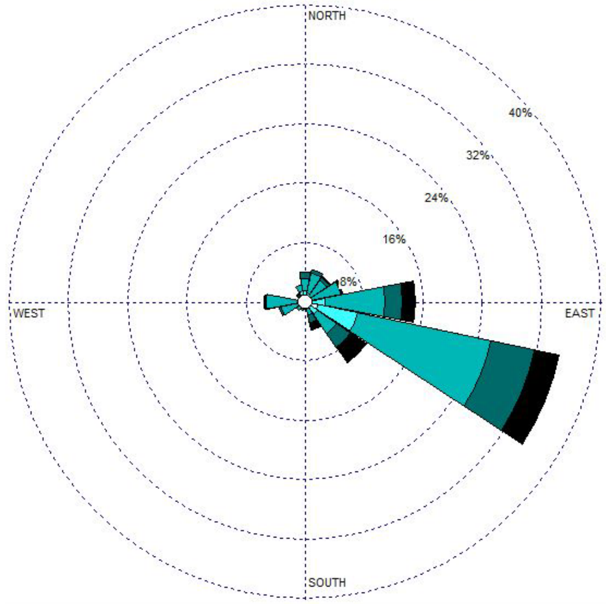


Figure 5-15: 2012 Ozone Pollution Rose DV

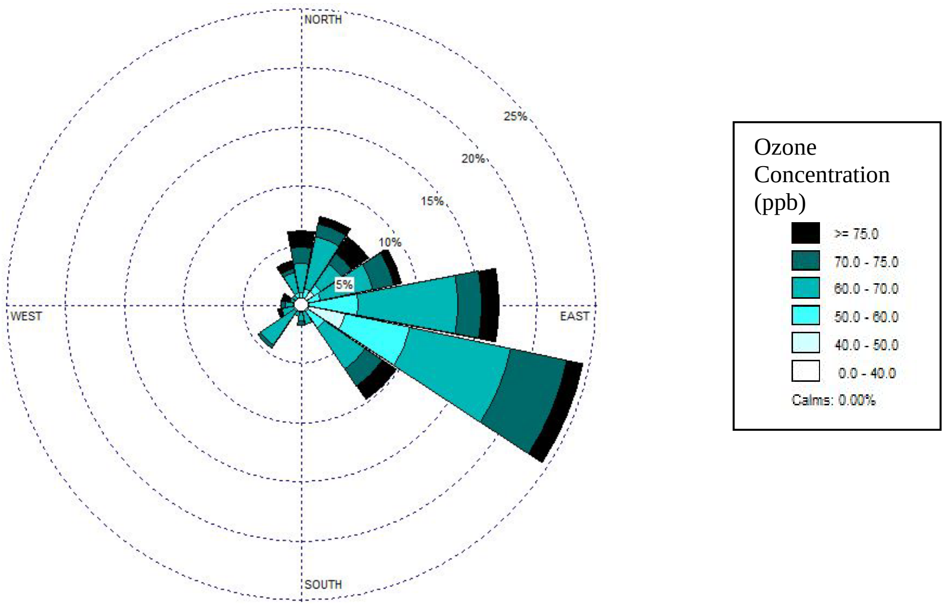


Figure 5-16: 2013 Ozone Pollution Rose DV

5.2.3 Sunland Park - Wind Rose and Ozone Pollution Rose: 2006 to 2013 (10 A.M. – 6 P.M.)

The wind rose (Figure 5-17) for 2006 to 2013 for the Sunland Park monitoring station, showed that the predominant area winds were from the east southeastern (ESE) direction (24% of the time), followed by southeast (SE) winds 11% of the time and east (E) at 9%. Overall, 35 % of wind speeds

present were between 0.5 to 2.1 m/s, 41% were between 2.1 to 3.6 m/s, 18% were between 3.6 to 5.7 m/s, 5% were between 5.7 to 8.8 m/s and less than 1% of wind speeds were greater than 8.8 m/s. Winds from the ESE direction blew approximately 12% of the time at relatively low wind speeds (between 2.1 to 3.6 m/s), followed by wind speeds between 3.6 to 5.7 m/s (8% of the time). Southeast (SE) winds were dominated by wind speeds (between 2.1 to 3.6 m/s) 6% of the time, followed by wind speeds between 0.5 – 2.1 m/s (2% of the time). East winds blew at winds speeds between 2.1 to 3.6 m/s (5% of the time), followed by wind speeds between 3.6 – 5.7 m/s (2% of the time). Table 5-6 presents the wind rose statistics for Sunland Park monitoring station from 2006-2013.

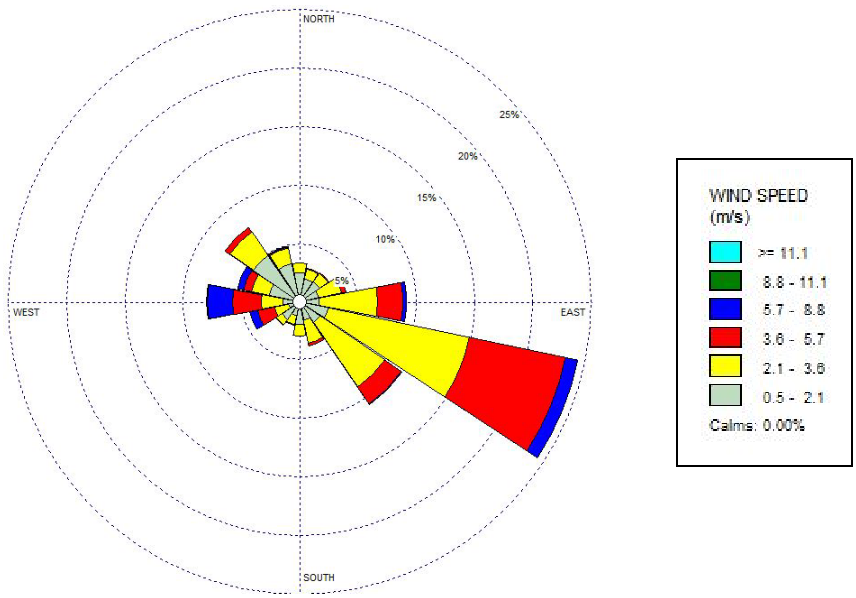


Figure 5-17: Wind Rose for Sunland Park Monitoring Station from 2006 through 2013

Table 5-6: Percentage of Frequency Distribution of Wind Direction and Wind Speed at Sunland Park Monitoring Station from 2006 through 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	Total
N	2.5	0.8	0.1	0.0	0.0	0.0	3.4
NNE	2.1	0.9	0.1	0.0	0.0	0.0	3.0
NE	2.1	0.9	0.1	0.0	0.0	0.0	3.0
ENE	1.7	2.0	0.3	0.1	0.0	0.0	4.1
E	1.7	5.0	2.1	0.3	0.0	0.0	9.1
ESE	2.5	12.3	8.4	1.1	0.0	0.0	24.3
SE	2.2	6.6	1.7	0.1	0.0	0.0	10.6
SSE	1.7	2.0	0.2	0.0	0.0	0.0	3.8
S	2.0	1.0	0.0	0.0	0.0	0.0	3.0
SSW	1.3	0.8	0.1	0.0	0.0	0.0	2.1
SW	1.9	0.6	0.1	0.0	0.0	0.0	2.5
WSW	1.0	1.3	1.5	0.7	0.0	0.0	4.4
W	1.5	1.9	2.5	2.1	0.1	0.0	8.0
WNW	2.7	1.5	0.7	0.6	0.0	0.0	5.5
NW	4.8	2.4	0.5	0.0	0.0	0.0	7.7
NNW	3.3	1.4	0.1	0.1	0.0	0.0	4.9
Sub-Total	34.8	41.2	18.3	5.0	0.1	0.0	99.3
Calms							0.4
Missing/Incomplete							0.3

Wind rose plots for the Sunland Park monitoring station showed that for 2006 (Figure 5-18), 2012 (Figure 5-19) and 2013 (Figure 5-20), prevailing winds were from the ESE wind direction, at 24%, 31% and 20% of the time, respectively. Similar to the Desert View monitoring station, the dominant winds within the ESE direction for the Sunland Park monitoring station were at lower wind speeds between 2.1 – 3.6 m/s occurring at 16% (Year 2006), 14% (Year 2012), and 11% (Year 2013) of time. The second highest dominate wind speed within the ESE direction, were the more moderate wind conditions (3.6 m/s to 5.7 m/s), occurring 7% (Year 2006), 14% (Year 2012) and 6% (Year 2013) of the time. In 2013, compared to 2006 and 2012, the monitoring station experienced slightly higher frequent winds coming from the west-northwest (WNW) and northwest (NW) directions. Summary tables of the wind statistics from 2006, 2012 and 2013 for the Sunland Park monitoring station have been included in Appendix D.

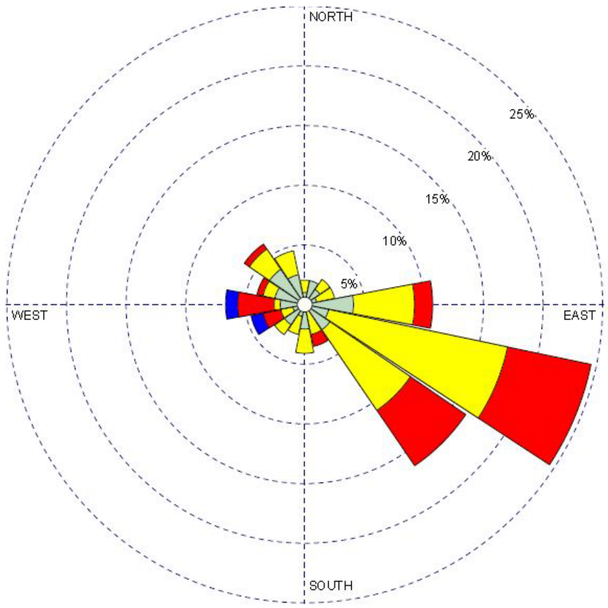


Figure 5-18: 2006 Wind Rose SP

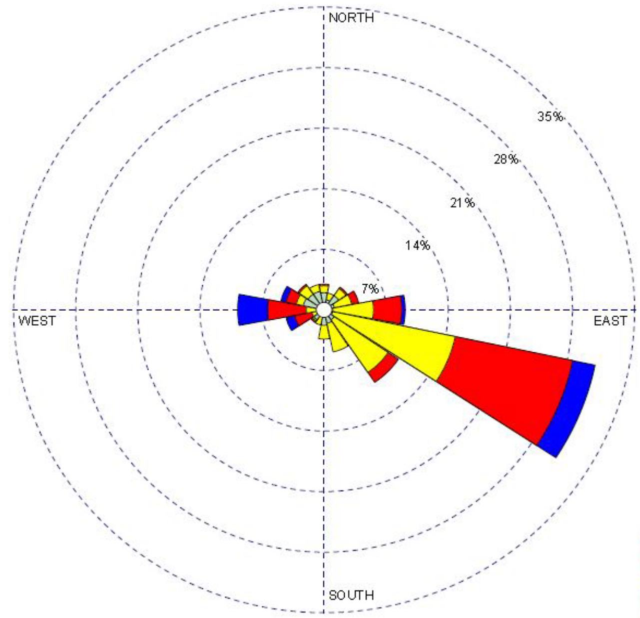


Figure 5-19: 2012 Wind Rose SP

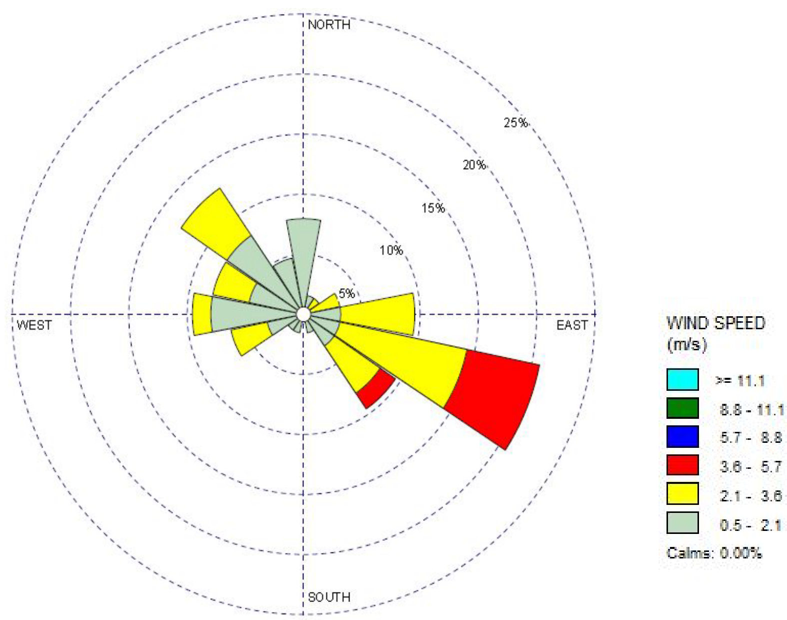


Figure 5-20: 2013 Wind Rose SP

The ozone pollution rose (Figure 5-21) from 2006 to 2013, showed that the majority of ozone concentrations arriving at the Sunland Park monitoring station for the eight years is from ESE direction (20% of the time), followed by southeast (13% of the time) and east (9% of the time) directions (Table

5-7). Winds for the 8 years blew approximately 1% of the time between 0 to 40 ppb, 4% at 40 to 50 ppb, 20% at 50 to 60 ppb, 38% at 60 to 70 ppb, 11% at 70 to 75 ppb and 11% at concentrations greater than 0.075 ppb (Table 5-7). Winds from the east direction blew approximately 3% of the time for ozone concentrations greater than 75 ppb, followed by SE and NW winds, 2% of the time (Table 5-7).

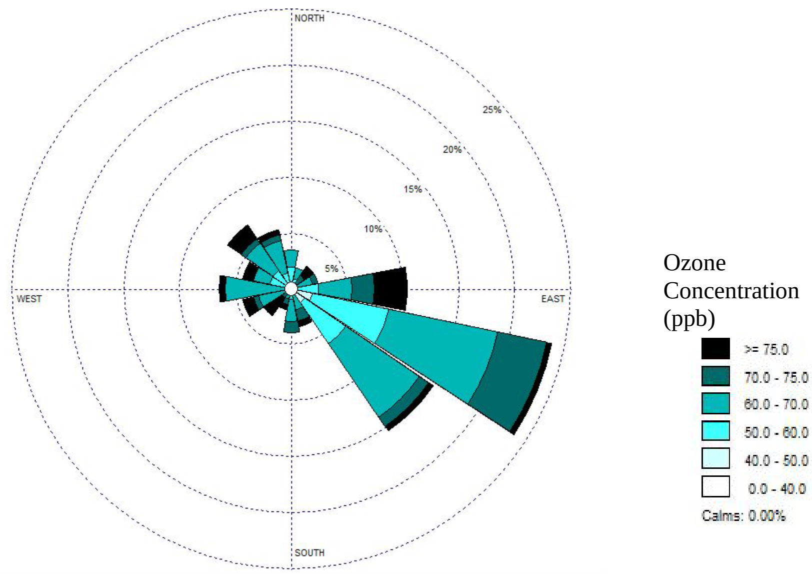


Figure 5-21: Ozone Pollution Rose for Sunland Park Monitoring Station
from 2006 through 2013

Table 5-7: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration at Sunland Park Monitoring Station from 2006 through 2013

Directions / Ozone Concentration (ppb)	0.0 - 40.0	40.0 - 50.0	50.0 - 60.0	60.0 - 70.0	70.0 - 75.0	>= 75.0	
N	0.0	0.5	1.5	1.5	0.0	0.0	2.9
NNE	0.0	0.0	1.0	1.0	0.0	0.0	1.7
NE	0.5	0.0	0.0	0.0	1.0	1.0	2.1
ENE	0.0	0.5	0.0	1.5	0.5	0.0	2.1
E	0.0	0.0	2.5	3.0	2.0	3.0	8.8
ESE	0.5	1.5	6.9	9.9	4.5	0.5	20.2
SE	0.0	1.5	4.5	7.9	1.0	0.5	13.0
SSE	0.0	0.0	0.0	2.0	1.0	0.5	2.9
S	0.0	0.0	1.0	2.0	1.0	0.0	3.4
SSW	0.0	0.5	0.0	0.5	0.5	0.5	1.7
SW	0.0	0.0	0.5	0.0	0.5	2.0	2.5
WSW	0.0	0.0	0.5	2.5	0.5	1.0	3.8
W	0.0	0.0	0.0	5.9	0.0	0.5	5.5
WNW	0.0	0.0	2.0	1.5	0.0	1.0	3.8
NW	0.0	0.0	2.0	3.0	0.5	1.5	5.9
NNW	0.0	0.0	1.5	3.0	0.5	0.5	4.6
Sub-Total	0.8	3.8	20.2	38.2	11.3	10.5	84.9
Calms							0.0
Missing/Incomplete							15.1

For 2006 (Figure 5-22), 3% of the time winds from the east blew at ozone concentrations greater than 75 ppb; ozone concentrations (>75ppb) were also observed in various other wind directions. For 2012 (Figure 5-23) winds from both the ESE and SE directions indicated that 3% of the time ozone concentrations were greater than 75 ppb. Ozone concentrations (>75 ppb) were also observed for several other wind directions at less frequencies. For 2013 (Figure 5-24), 2% of the time winds blew from the ENE and ESE wind directions at ozone concentrations (>75ppb). Summary tables of the ozone pollution rose statistics from 2006, 2012 and 2013 for the Sunland Park monitoring station have been included in Appendix D.

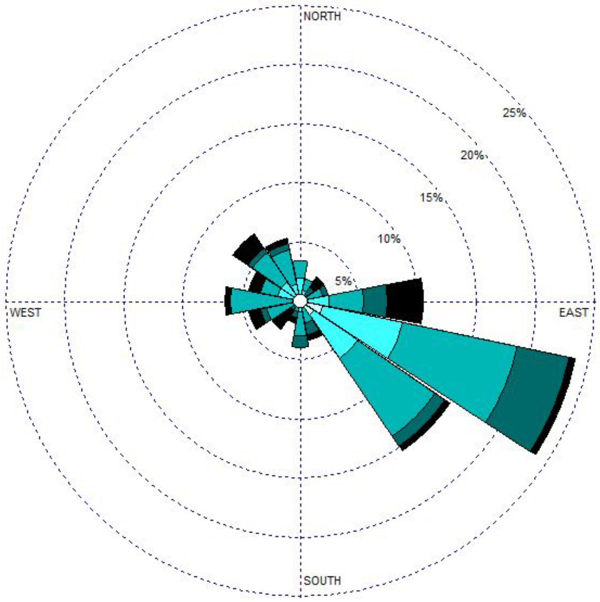


Figure 5-22: 2006 Ozone Pollution Rose SP

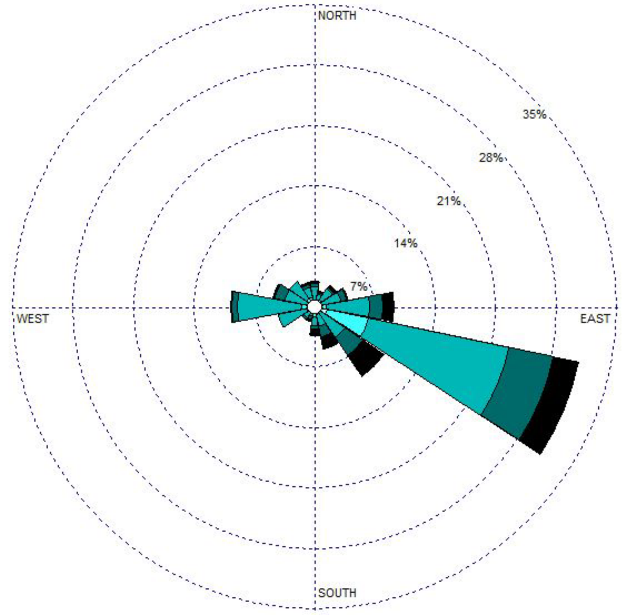


Figure 5-23: 2012 Ozone Pollution Rose SP

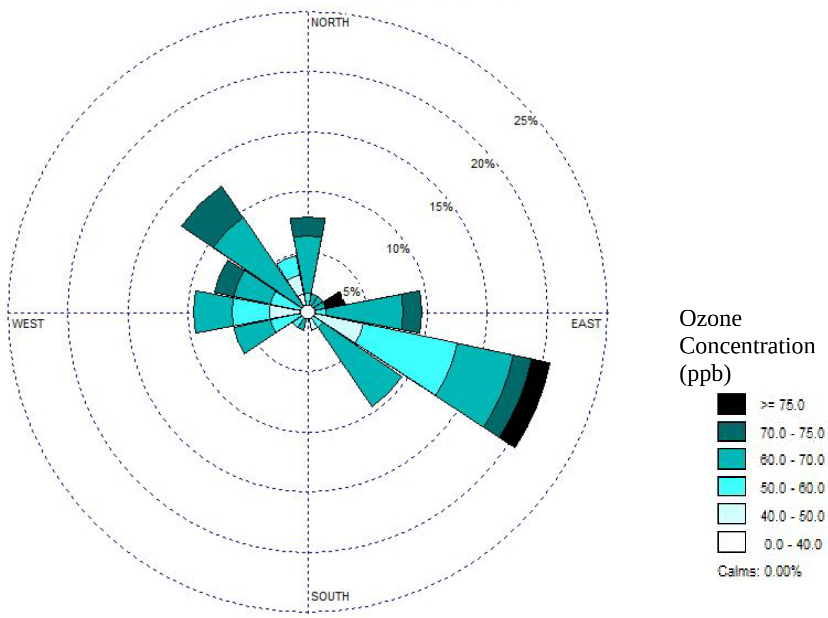


Figure 5-24: 2013 Ozone Pollution Rose SP

5.2.4 UTEP - Wind Rose and Ozone Pollution Rose: 2006 to 2013 (10 A.M. – 6 P.M.)

The wind rose (Figure 5-25) for the UTEP monitoring station from 2006 to 2013, showed that prevailing area winds were from the east southeastern (ESE) direction (24% of the time), followed by southeast (SE) winds (16% of the time) and east (E) winds (9% of the time). Overall, 46% of wind

speeds present were between 0.5 to 2.1 m/s, 38% were between 2.1 to 3.6 m/s, 12% were between 3.6 to 5.7 m/s, 1% were between 5.7 to 8.8 m/s and no wind speeds greater than 8.8 m/s were observed. Examining winds from the ESE direction, approximately 12% of the time winds blew at relatively low wind speeds (between 2.1 to 3.6 m/s), followed by near calm conditions (wind speeds less than 2.1 m/s) 8% of the time. Southeast (SE) winds were dominated by wind speeds between 2.1 to 3.6 m/s (8% of the time), followed by wind speeds between 0.5 – 2.1 m/s (7% of the time). East wind speeds blew between 2.1 to 3.6 m/s (5% of the time) and 3.6 – 5.7 m/s (4% of the time). Table 5-8 presents the wind rose statistics for the UTEP monitoring station from 2006-2013.

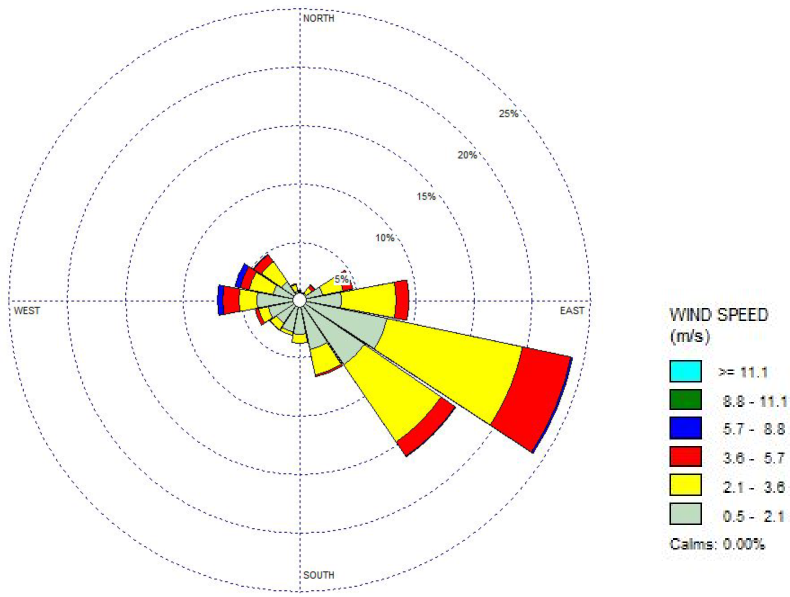


Figure 5-25: Wind Rose for UTEP Monitoring Station from 2006 through 2013

Table 5-8: Percentage of Frequency Distribution of Wind Direction and Wind Speed at UTEP Monitoring Station from 2006 through 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	Total
N	0.7	0.1	0.0	0.0	0.0	0.0	0.9
NNE	0.5	0.1	0.1	0.0	0.0	0.0	0.7
NE	0.7	0.6	0.3	0.1	0.0	0.0	1.7
ENE	2.1	1.8	0.8	0.0	0.0	0.0	4.7
E	3.6	4.7	1.1	0.0	0.0	0.0	9.4
ESE	7.7	11.9	4.2	0.1	0.0	0.0	23.9
SE	6.8	7.9	1.4	0.1	0.0	0.0	16.2
SSE	4.4	2.2	0.2	0.0	0.0	0.0	6.7
S	2.9	0.8	0.0	0.0	0.0	0.0	3.7
SSW	2.8	0.3	0.0	0.0	0.0	0.0	3.1
SW	2.4	0.7	0.0	0.0	0.0	0.0	3.1
WSW	2.8	0.8	0.4	0.0	0.0	0.0	4.0
W	3.7	1.6	1.4	0.5	0.0	0.0	7.0
WNW	2.4	2.1	0.8	0.5	0.0	0.0	5.7
NW	1.9	2.1	0.7	0.1	0.0	0.0	4.8
NNW	0.8	0.6	0.1	0.0	0.0	0.0	1.5
Sub-Total	46.1	38.1	11.6	1.3	0.0	0.0	97.1
Calms							2.8
Missing/Incomplete							0.1

Wind rose plots for the UTEP monitoring station showed that for 2006 (Figure 5-26), 2012 (Figure 5-27) and 2013 (Figure 5-28), the dominant prevailing winds were from the ESE direction, at 22%, 31% and 21% of the time, respectively. The dominant winds within the ESE direction were at lower wind speeds between 2.1 – 3.6 m/s occurring at 11% (Year 2006), 17% (Year 2012), and 11% (Year 2013) of time. The second highest dominate wind speed within the ESE direction, were the calmer wind conditions (0.5 to 2.1 m/s), occurring 6% (Year 2006), 7% (Year 2012) and 7% (Year 2013) of the time. Summary tables of the wind statistics from 2006, 2012 and 2013 for the UTEP monitoring station have been included in Appendix D.

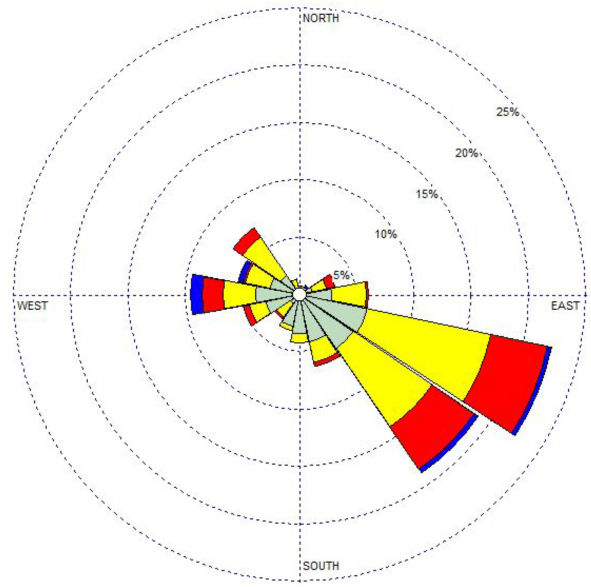


Figure 5-26: 2006 Wind Rose UT

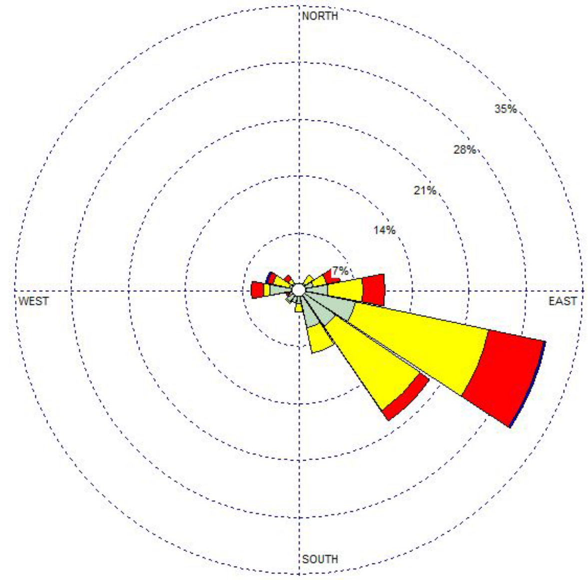


Figure 5-27: 2012 Wind Rose UT

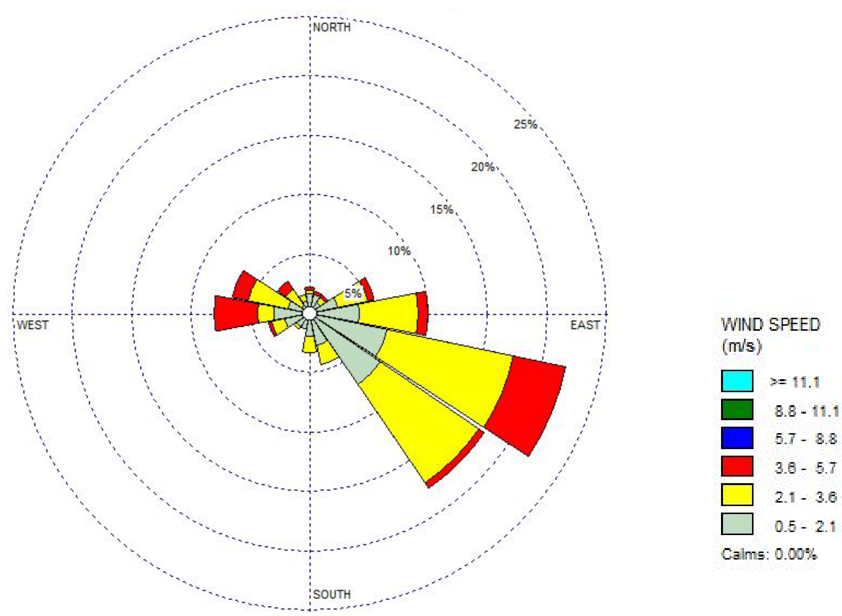


Figure 5-28: 2013 Wind Rose UT

The ozone pollution rose (Figure 5-29) from 2006 to 2013, showed that the majority of ozone concentrations arriving at the UTEP monitoring station was from ESE direction (23% of the time), followed by southeast (16% of the time) and east (9% of the time) directions (Table 5-9). Winds for all 8 years blew approximately 2% of the time between 0 to 40 ppb, 7% at 40 to 50 ppb, 19% at 50 to 60 ppb,

40% at 60 to 70 ppb, 11% at 70 to 75 ppb and 18% at concentrations greater than 75 ppb. Both the ESE and E directions blew 4% of the time at ozone concentrations greater than 75 ppb.

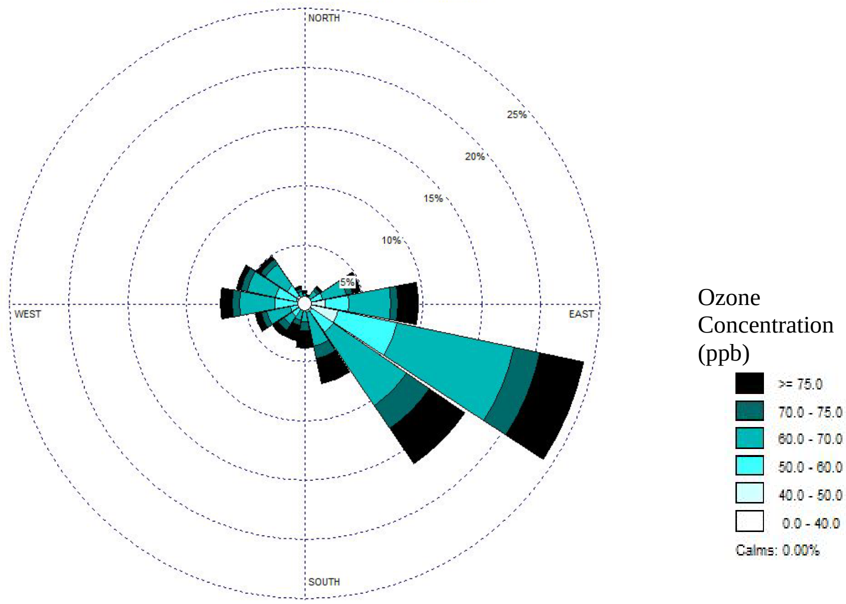


Figure 5-29: Ozone Pollution Rose for UTEP Monitoring Station from 2006 to 2013

Table 5-9: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration at UTEP Monitoring Station from 2006 through 2013.

Directions / Ozone Concentration (ppb)	0.0 - 40.0	40.0 - 50.0	50.0 - 60.0	60.0 - 70.0	70.0 - 75.0	>= 75.0	
N	0.0	0.0	0.3	0.5	0.0	0.2	1.1
NNE	0.0	0.0	0.2	0.3	0.1	0.2	0.8
NE	0.0	0.1	0.2	1.0	0.3	0.2	1.8
ENE	0.0	0.2	1.4	1.9	0.5	0.7	4.7
E	0.4	1.4	2.0	3.5	0.7	1.7	9.4
ESE	0.4	2.6	5.1	10.1	2.2	3.7	23.4
SE	0.2	0.6	2.2	7.5	2.3	3.6	16.0
SSE	0.0	0.1	0.7	2.9	1.1	2.2	6.8
S	0.0	0.1	0.4	1.0	0.7	1.5	3.7
SSW	0.0	0.0	0.5	1.0	0.4	1.3	3.2
SW	0.2	0.4	0.8	0.9	0.6	0.5	3.2
WSW	0.1	0.2	0.9	2.0	0.5	0.5	4.2
W	0.1	0.5	1.9	3.1	0.6	0.9	6.9
WNW	0.2	0.6	1.7	2.5	0.5	0.4	5.8
NW	0.2	0.6	1.0	2.2	0.5	0.4	4.8
NNW	0.0	0.1	0.1	0.9	0.2	0.2	1.5
Sub-Total	1.8	7.3	19.0	40.1	11.1	18.0	97.3
Calms							0.0
Missing/Incomplete							2.7

For 2006 (Figure 5-30), the UTEP monitoring station observed the poorest air quality (ozone concentrations > 75 ppb) when the winds were from the ESE, SE and SSE direction; ozone concentrations (>75ppb) were also observed several other wind directions. For 2012 (Figure 5-31), 4% and 3% of the time, respectively, winds from the ESE and SE directions blew at ozone concentrations greater than 75 ppb; ozone concentrations (>75 ppb) were also observed in several directions as well. For 2013 (Figure 5-32), 2% of the time, winds blew from the ESE, SE and S directions at ozone concentrations greater than 75ppb; ozone concentrations (>75ppb) were also observed in other directions as well. Summary tables of the ozone pollution rose statistics from 2006, 2012 and 2013 for the UTEP monitoring station have been included in Appendix D.

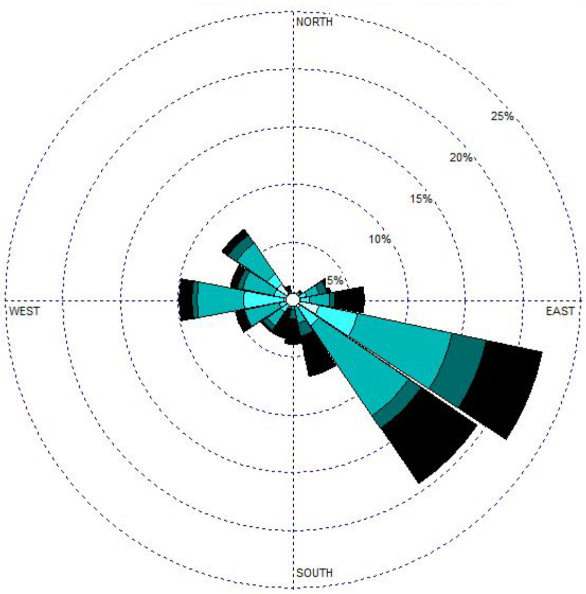


Figure 5-30: 2006 Ozone Pollution Rose UT

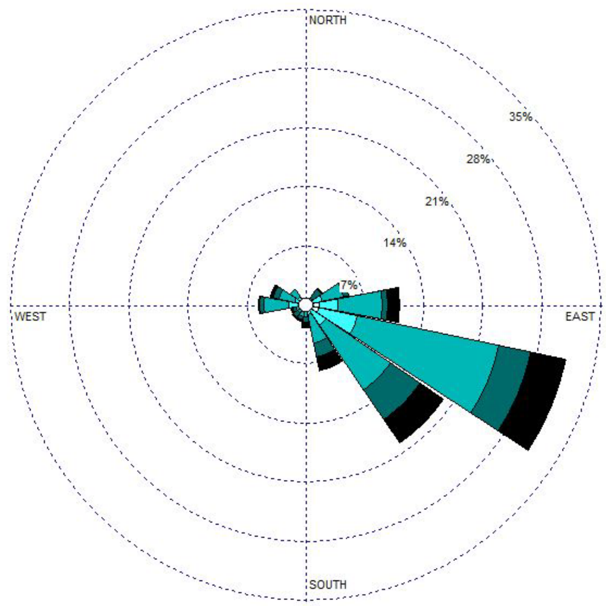


Figure 5-31: 2012 Ozone Pollution Rose UT

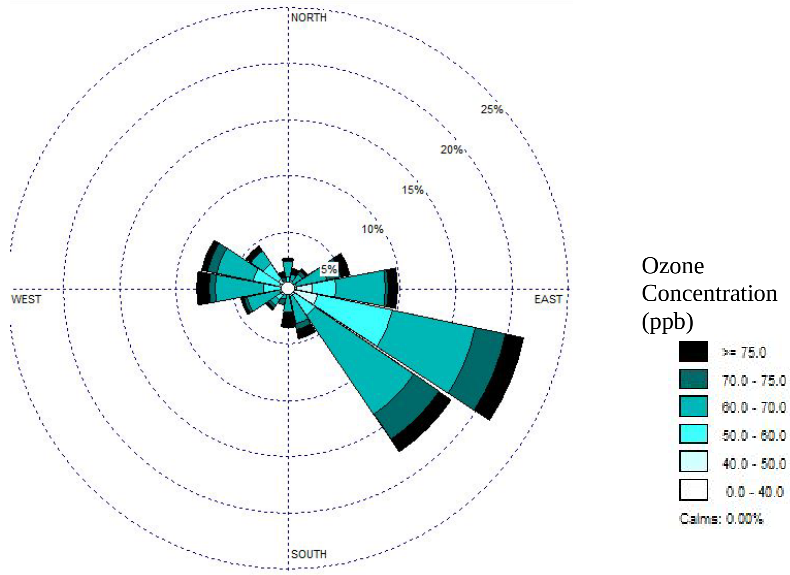


Figure 5-32: 2013 Ozone Pollution Rose UT

5.3 Summary of Wind Rose and Pollution Rose Analysis

Wind rose plots from 2006 through 2013 for the Santa Teresa, Desert View, Sunland Park and UTEP air quality monitors showed that the prevailing winds for all four monitoring stations, were from the east-southeast (ESE) direction (ranging from 20% to 27% of the time) followed by winds in either the east direction (ranging from 9 to 13% of the time) or southeast direction (ranging from 8 to 16% of the time). From 2006 to 2013, ESE winds at the Santa Teresa monitoring station, were dominated by moderate wind speeds (between 3.6 to 5.7 m/s) 14% of the time, followed by low wind speeds (2.1 to 3.6 m/s) 8% of the time. East-southeast (ESE) winds blew at low wind speeds (between 2.1 to 3.6 m/s) 13% and 12% of the time, respectively, for both the Desert View and Sunland Park monitors; followed by moderate wind speeds (between 3.6 to 5.7 m/s) 7% and 8% of the time, respectively. The ESE winds at the UTEP monitoring station, were dominated by low wind speeds (between 2.1 to 3.6 m/s) 12% of the time, followed by calm to low wind speeds (between 0.5 to 2.1 m/s) 8% of the time.

The individual 2006, 2012 and 2013 wind rose plots for each of the stations were consistent with the wind rose plots from 2006 through 2013. The prevailing winds were from the ESE direction for each of the monitors for 2006, 2012 and 2013; followed by winds in either the E or SE direction. The ESE winds at the Santa Teresa monitoring station were dominated by wind speeds (between 3.6 to 5.7 m/s)

12%, 18% and 14% of the time for 2006, 2012 and 2013, respectively; followed by wind speeds (between 2.1 to 3.6 m/s) 9%, 11% and 5% of the time for 2006, 2012 and 2013, respectively. The ESE winds at the Desert View monitoring station were dominated by wind speeds (between 2.1 to 3.6 m/s) 12%, 19% and 13% of the time for 2006, 2012 and 2013, respectively; followed by wind speeds (between 3.6 to 5.7 m/s) 6%, 13% and 8% of the time for 2006, 2012 and 2013, respectively. The ESE winds at the Sunland Park monitoring station, were dominated by relatively low wind speeds (between 2.1 to 3.6 m/s) 15%, 14% and 11% of the time for 2006, 2012 and 2013, respectively; followed by moderate wind speeds (between 3.6 to 5.7 m/s) 7%, 14% and 6% of the time for 2006, 2012 and 2013, respectively. The ESE winds at the UTEP station were dominated by low wind speeds (between 2.1 to 3.6 m/s) 11%, 17% and 11% of the time for 2006, 2012 and 2013, respectively; followed by calm to low wind speeds (between 0.5 to 2.1 m/s) 6%, 7% and 7% of the time for 2006, 2012 and 2013, respectively.

The ozone pollution roses were visually similar to the wind rose from 2006 to 2013, such that the prevailing direction for the majority of ozone arriving at the stations was in the same prevailing direction that was observed in the wind rose. The majority of ozone arriving at the four stations from 2006 through 2013, was from the ESE direction, followed either an east (E), southeast (SE) or west (W) direction. Winds at the Santa Teresa monitoring station from 2006 through 2013 blew approximately 1% of the time between 0 to 40 ppb, 4% at 40 to 50 ppb, and 19% at 50 to 60 ppb, 49% at 60 to 70 ppb, 13% at 70 to 75 ppb and 10% at concentrations greater than 75 ppb (Table 5-3). For 2006, 2012 and 2013 the majority of ozone concentrations greater than 75ppb were observed when the winds were from east-southeast (ESE) direction.

Winds at the Desert View monitoring station from 2006 to 2013 blew approximately 1% of the time between 0 to 40 ppb, 6% at 40 to 50 ppb, and 19% at 50 to 60 ppb, 45% at 60 to 70 ppb, 12% at 70 to 75 ppb and 15% at concentrations greater than 75 ppb. East-southeast (ESE) winds blew 3% of the time at ozone concentrations greater than 75 ppb, followed by E and SE winds at 1.6% and 1.4%, respectively (Table 5-3). East-southeast (ESE) winds blew 3% of the time at ozone concentrations greater than 75 ppb, followed by E and SE winds at 1.6% and 1.4%, respectively. For 2006, 2012 and

2013 specifically, the majority of ozone concentrations greater than 75ppb were observed when the winds were from either the, east (E), east-southeast (ESE) direction or southeast (SE) directions.

Winds at the Sunland Park monitoring station from 2006 to 2013 blew approximately 1% of the time between 0 to 40 ppb, 4% at 40 to 50 ppb, 20% at 50 to 60 ppb, 38% at 60 to 70 ppb, 11% at 70 to 75 ppb and 11% at concentrations greater than 75 ppb. Winds from the east direction blew approximately 3% of the time for ozone concentrations greater than 75 ppb, followed by SE and NW winds, 2% of the time. For 2006, 2012 and 2013 specifically, the majority of ozone concentrations greater than 75ppb were observed when the winds were from east-southeast (ESE) direction.

Winds at the UTEP monitoring station from 2006 to 2013 blew approximately 2% of the time between 0 to 40 ppb, 7% at 40 to 50 ppb, 19% at 50 to 60 ppb, 40% at 60 to 70 ppb, 11% at 70 to 75 ppb and 18% at concentrations greater than 75 ppb. Both the ESE and E directions blew 4% of the time at ozone concentrations greater than 75 ppb. For 2006, 2012 and 2013 specifically, the majority of ozone concentrations greater than 75ppb were observed when the winds were from east-southeast (ESE) direction and/or southeast (SE) directions.

Chapter 6: HYSPLIT_4 Modeling System

6.1 HYSPLIT Cluster Trajectory Analysis

6.1.1 HYSPLIT Model Setup for Daily and Cluster Backward Trajectory Analysis for 72-Hour Model Runs

The National Oceanic and Atmospheric Administration (NOAA) HYSPLIT model was utilized to conduct backward trajectory analysis to determine regional and/or long-range transport sources contributing to the ozone pollution in the study area. The HYSPLIT Model 4 PC version was utilized to develop the daily and cluster backward trajectory analysis for the years 2006, 2012 and 2013. As with the wind and pollution rose analysis, these years were selected because two out of the three years represented the most recent ozone seasons; 2006 was selected as it had as many high ozone days as 2012 and 2013. The ozone season was defined between the months of May 1 through September 31 of each year, with a high ozone day defined as day which had a daily maximum 8-hour ozone concentration greater than 0.06 ppm (60 ppb). Again, only the 10 A.M. to 6 P.M. hours were used for each day. Tables included in Appendix B identify the high ozone days utilized in the HYSPLIT runs. However, unlike the wind roses which were are specific to a station location and were created utilizing the high ozone days for that station, the HYSPLIT daily runs for each year took into account all of the high ozone days for all four stations within that particular year. That is, the only days that were excluded in each year, were those days in which all four stations (6ZN-Santa Teresa, 6ZM-Desert View, 6ZG-Sunland Park and C12-UTEP) did not have a high ozone day (or the days in the blue columns in Appendix B tables).

The archived meteorological dataset utilized was the EDAS 40 km as this dataset represented the finest spatial resolution for North America that is available for this study that included the three specific years chosen. EDAS represents large-scale flows and cannot accurately represent local to mesoscale phenomena such as topography influence flow. Additional information regarding the specifics of the dataset can be found at (https://ready.arl.noaa.gov/edas40.php). The meteorological data files downloaded for each year was: 1) Second half of April, 2) 1st and 2nd half of May through September.

The site selection for the model run was the GPS coordinates for the Santa Teresa monitor. Since the meteorological dataset is on a 40-km grid system, the model doesn’t distinguish between the two monitoring stations furthest apart (i.e. Santa Teresa and UTEP), which are no more than 10 miles from

one another. The backward trajectories would all be very similar to one another whether one station location was used versus another.

A 72-hour backward trajectory analysis was conducted for each of the daily runs. It should be noted that if there was missing data within the metrological dataset within a run, for example, a full 72-hour trajectory may not be possible for some daily trajectories; therefore these trajectories were dropped from the cluster analysis and noted as “trajectories not clustered” in the HYSPLIT file output.

The 1996 Paso del Norte Study indicated that peak hourly ozone concentration occurs at approximately noon near Downtown El Paso. A more recent study, Rider 8 Conceptual Model for Ozone Reduction (Li et al., 2011) looking at 10-years of diurnal variations of ozone concentration found that ozone concentrations tend to peak at approximately 2 p.m. and as the summer progresses the diurnal peaks to progressively later hours. For this study, a start time of 12:00 P.M. (18 UTC) was chosen for each daily run.

The height chosen for the daily model runs was 500 m above ground level (AGL) to “represent a well-mixed convective boundary layer” (Xu, et.al., 2010). It should be noted if the model is run at a height very low to the ground (i.e. such at a 10m height, same height as the monitor), the model does not handle the data well and trajectories will hit the ground.

6.1.2 72- Hour Trajectory Cluster Analysis for 2006

For 2006, there were a total number of 71 trajectories based on the number of high ozone days for this ozone season. For the 72-hour trajectory cluster analysis, only forty-nine (49) trajectories were clustered; twenty-two (22) trajectories were lacking the meteorological data within the model for the full 72-hour run (Table 6-1).

Table 6-1: Summary of Trajectories Clustered and Not Clustered for 2006 (May 1 – September 31)

72-Hour		
Total Daily Trajectories Clustered	Total Daily Trajectories Not Clustered	Total Daily Trajectories
49	22	71

Table 6-2 indicates the number of clusters that was determined for each model run. There were seven clusters (Figure 6-1) determined for the 72-hour model run, based on the analysis of the TSV (Appendix E, Figure E-8). For the 72-hour trajectory cluster analysis, 26% of the trajectories (Cluster 2 & 7) transport ozone from the west (southern Arizona and California region). Approximately 22% of trajectories (Cluster 1) transport ozone from the southwest direction from regions within Mexico. Both Cluster 5 and Cluster 6 transport ozone from the southeast Texas and northern Mexican states or east Texas (18% of the time). Very little transport ozone was observed from the NW directions (4% only). Of the trajectories not clustered (Appendix E, Figure E-9), many of the trajectories appeared to be associated with a southeast direction as well.

Table 6-2: Summary of the 72-Hour Trajectory Cluster Analysis for 2006

72-Hour			
Cluster	%	Directions	# of Trajectories
1	22	SW	11
2	16	W	8
3	4	NW	2
4	10	NE	5
5	18	SE	9
6	18	E	9
7	10	W	5

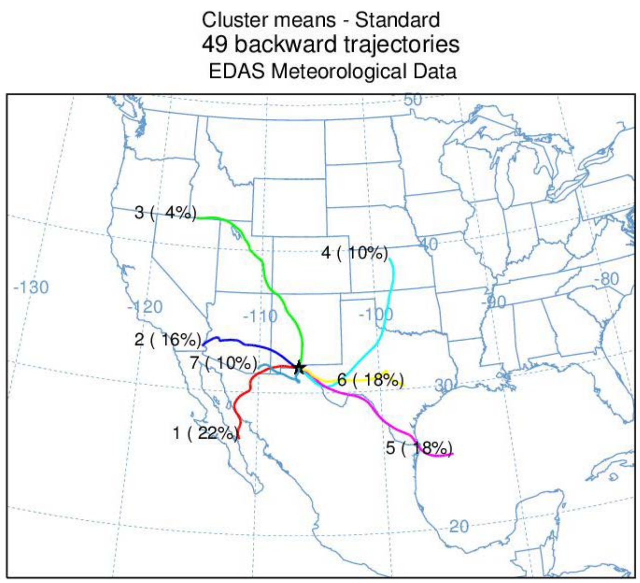


Figure 6-1: 72-Hour Mean Trajectories for 2006

6.1.3 72-Hour Trajectory Cluster Analysis for 2012

For 2012, there were a total number of seventy-one (71) trajectories based on the number of high ozone days for this ozone season. Table 6-3 shows that for the 72-hour trajectory cluster analysis, sixty-nine (69) trajectories were clustered; two trajectories were lacking the meteorological data within the model for the full 72-hour run.

Table 6-3: Summary of Trajectories Clustered and Not Clustered for 2012 (May 1 – September 31)

72-Hour		
Total Daily Trajectories Clustered	Total Daily Trajectories Not Clustered	Total Daily Trajectories
69	2	71

Table 6-4 shows that seven (Figure 6-2) clusters were determined for the 72-hour model run based on the analysis of the TSV (Appendix F, Figure F-9). For the 72-hour trajectory cluster analysis, approximately 43% (Cluster 5 and Cluster 6) of the high ozone days were associated with long-range transport ozone from the southeast direction. Cluster 4 (17%) from the west direction, picked up

transport ozone pollution from parts of central Arizona and southern California. The major metropolitan areas of Phoenix and Tucson are more than likely contributing to this region based on the direction of these trajectories through Arizona. Approximately 13% of trajectories (Cluster 1) transport ozone were from the southwest direction from regions within Mexico. Approximately 26% of trajectories (Cluster 2, Cluster 3 and Cluster 7) transport ozone from the northeast direction from regions through the panhandle of Texas, Oklahoma and Missouri. Trajectories not clustered are included in Appendix F (Figure F-8).

Table 6-4: Summary of the 72-Hour Trajectory Cluster Analysis for 2012

72-Hour			
Cluster	%	Directions	# of Trajectories
1	13	SW	9
2	7	NE	5
3	16	NE	11
4	17	W	12
5	29	SE	20
6	14	SE	10
7	3	NE	2

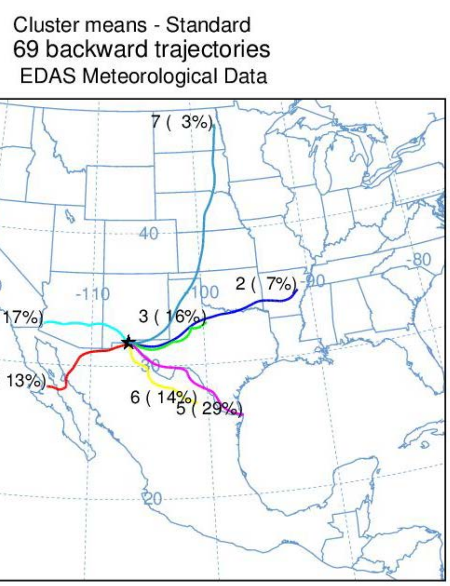


Figure 6-2: 72-Hour Mean Trajectories for 2012

6.1.4 72-Hour Trajectory Cluster Analysis for 2013

For 2013, there were a total number of ninety-four (94) trajectories (Table 6-5) based on the number of high ozone days for this ozone season. Only eighty (80) trajectories were clustered for the 72-hour run; 14 trajectories were lacking the meteorological data within the model for the full 72-hour run.

Table 6-5: Summary of Trajectories Clustered
and not Clustered for 2013 (May 1 – September 31)

72-Hour		
Total Daily Trajectories Clustered	Total Daily Trajectories Not Clustered	Total Daily Trajectories
80	14	94

Table 6-6 shows that eleven (Figure 6-3) clusters were determined for the 72-hour model run based on the analysis of the TSV (Appendix G, Figure G-13). The 72-hour trajectory cluster analysis showed that 14% of the trajectories (Cluster 3) originate in the west and transport ozone from regions within northern Mexico. Approximately 22% of trajectories (Cluster 1 and Cluster 8) that originate from the southwest direction, transport ozone pollution from regions within Mexico as well. Approximately 42% of trajectories (Cluster 9, Cluster 10 and Cluster 11) arrive from the southeast direction, from regions within northern Mexico, as well as southeast Texas. Ozone transport originates from the NW, NE and E directions 7%, 9% and 6%, respectively. The trajectories not clustered are found in Appendix G (Figure G-12).

Table 6-6: Summary of the 72-Hour Trajectory Cluster Analysis for 2013

72-Hour			
Cluster	%	Directions	# of Trajectories
1	16	SW	13
2	6	E	5
3	14	W	11
4	5	NE	4
5	4	NE	3
6	3	NW	2
7	4	NW	3
8	6	SW	5
9	20	SE	16
10	16	SE	13
11	6	SE	5

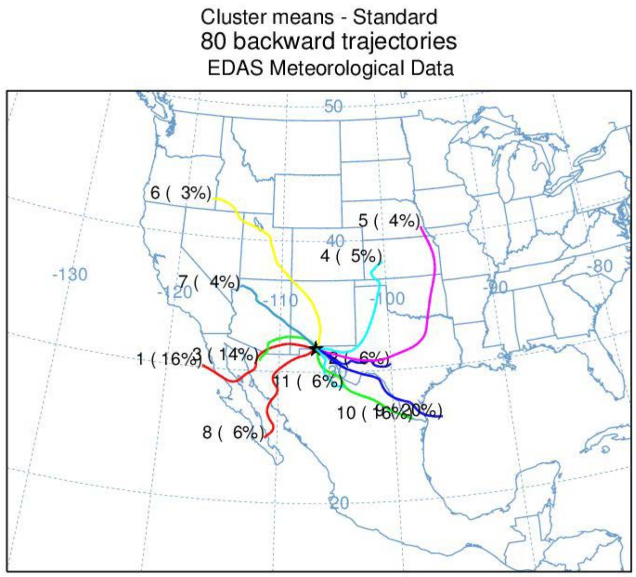


Figure 6-3: 72-Hour Mean Trajectories for 2013

6.2 Overview of Top 14 High Ozone Days for 2013 Santa Teresa Monitoring Station (72-hr Trajectory)

In 2013, there were a total of fourteen (14) days that exceeded the 8-hour ozone standard of 75 ppb at the Santa Teresa monitoring station. Table 6-7 lists these days and what clusters they were included for the 72-hour Mean Trajectories (Figure 6-3) described in the previous section. However, it should be noted that for July 16, meteorological data within model did not have the full 72-hour data

needed; therefore, it was not included in the 72-hour trajectory cluster analysis. Overall, six out of fourteen days exceeding the 8-hour ozone standard showed transport ozone from a southeast direction, either from southern Texas and/or the northern Mexican border states. Days in **BOLD** within the table indicate the top three days with the highest daily maximum 8-hour average ozone concentration for 2013. July 3, July 25 and July 27 indicated a daily maximum 8-hour average ozone concentration of 0.081 ppm, 0.081 ppm and 0.089 ppm, respectively. Of these three days, two out of the three were transported from regions within east or northeast Texas. Overall, July had the most days exceeding the 8-hour ozone standard with seven of the fourteen days, followed by the month of August with six days.

Table 6-7: Overview of Highest 14 days for 2013 Exceeding the 8-Hour Ozone Standard

Cluster 2 (E)	Cluster 3 (W)	Cluster 4 (NE)	Cluster 5 (NE)	Cluster 7 (NW)	Cluster 9 (SE)	Cluster 10 (SE)	Cluster 11 (SE)
July 3 (0.081 ppm)	June 27 (0.076 ppm)	**July 27 (0.089 ppm)**	July 2 (0.079 ppm)	Aug 9 (0.077 ppm)	July 7 (0.08 ppm)	Aug 21 (0.077 ppm)	**July 25 (0.081 ppm)**
Aug 16 (0.079 ppm)	July 31 (0.077 ppm)				Aug 12 (0.079 ppm)		Aug 17 (0.078 ppm)
							Aug 20 (0.076 ppm)

6.3 Overview of Top 3 Days that Exceeded the 8-hour Ozone Standard for 2013 at the Santa Teresa Monitoring Station

72-hour backward trajectories were conducted for the top three days for 2013 with the highest daily maximum 8-hour average ozone concentration at the Santa Teresa monitoring station. Unlike the cluster trajectory analysis, the online version of HYSPLIT was utilized to run each individual day's 72-hour backward trajectory. The start time of the 72-hour HYSPLIT runs was based on each individual day's high 1-hour ozone average. Starting heights were set up at 500 m, 1000 m and 1500 m above ground level. Again, 500 m captures a well mixed planetary boundary layer with the upper trajectories catching higher elevations of transport within the troposphere. For the purposes of this study, greater consideration should be given to the lower trajectories in terms of contributing to surface ozone pollution versus the trajectory from the upper troposphere (1000 m and 1500 m). Each figure displays

the vertical components (lower panel) and horizontal component (upper panel) of air mass trajectories arriving at the Santa Teresa station.

For July 3 (Figure 6-4), (was the day with the third highest daily maximum 8-hour average ozone concentration), the lower trajectories (500 m and 1000 m) appeared to stay within the boundary layer. The lower two trajectories appeared to be influenced by transport pollution originating from eastern Texas. As the trajectories traveled from the east, they head south into northern Mexico and then turn into a northwest direction where they approached the study area from the southeast. This is consistent with the 24-hour wind rose plot (Figure 6-5) for the station that indicates that prevailing winds were from the NNE and ESE directions. The 24-hour wind rose, overall, showed that the surface wind pattern was dominated by easterly winds (i.e. NNE, ENE, E, ESE, SE and SSE directions) at low wind speeds less than 3.6 m/s. Overall, the winds speeds blew at 17% of the time between 0.5 to 2.1 m/s, 63% at 2.1 to 3.6 m/s, and 21% at 3.6 to 5.7 m/s. Figure 6-6 is a wind rose plot presenting the hours of 10 A.M. – 6P.M.; it also showed that the majority of the winds for these 8-hours, were primarily low wind speeds less than 3.6 m/s from a southeasterly direction.

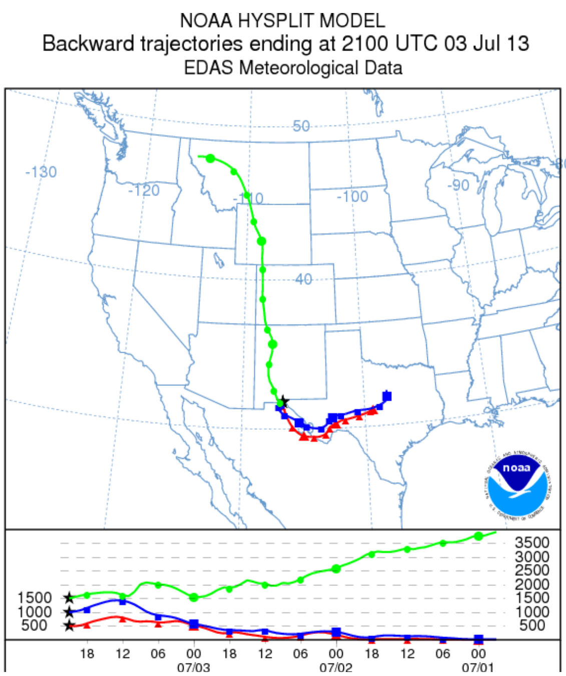


Figure 6-4: July 3, 2013, 72-hour Backward Trajectory at Santa Teresa Monitor.

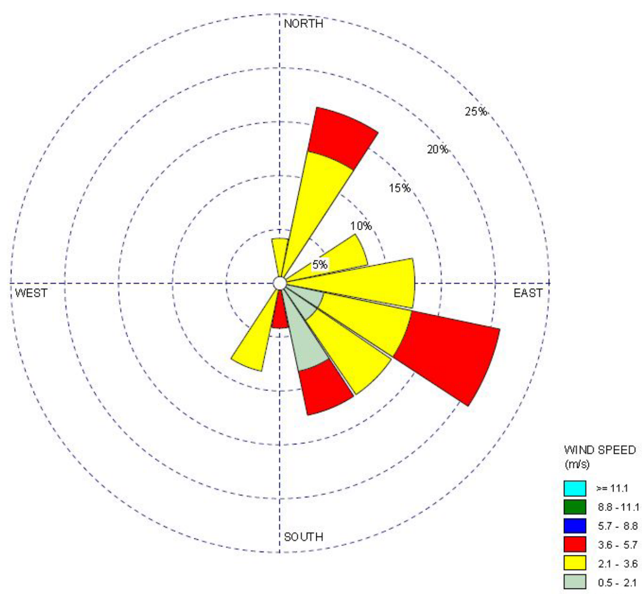


Figure 6-5: July 3, 2013, 24-hour Wind Rose Plot

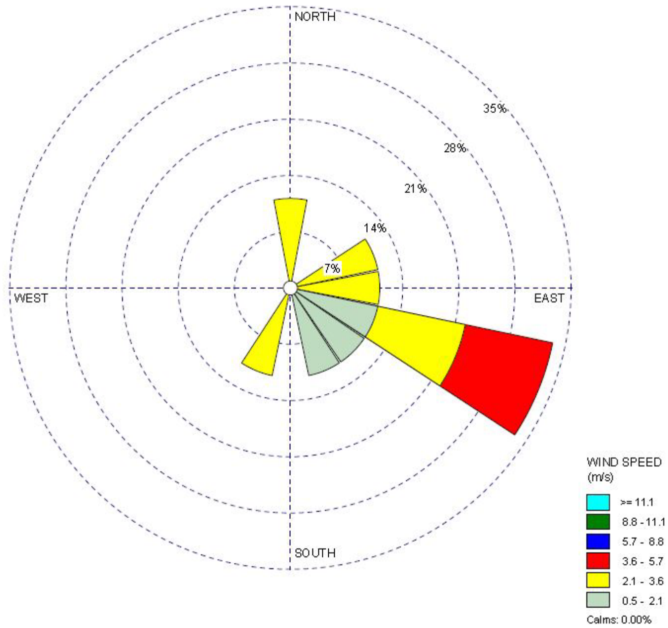


Figure 6-6: July 3, 2013, Wind Rose
between 10 A.M. to 6 P.M.

For July 25 (Figure 6-7), (was the day with the second highest daily maximum 8-hour average ozone concentration), as with July 3, the lower trajectories (500 m and 1000 m) appeared to stay within the boundary layer. The lower two trajectories originated from the southeast Texas and northern Mexican border states. Although the 24-hr wind rose plot (Figure 6-8) indicated that the prevailing winds were from the east direction, the station also experienced winds from the southeast, which was consistent with the back trajectories. The east direction winds had dominant wind speeds between 3.6 to 5.7 m/s. Overall, the winds speeds blew at 42% of the time between 0.5 to 2.1 m/s, 17% at 2.1 to 3.6 m/s, 37% at 3.6 to 5.7 m/s and 4% at 5.7 to 8.8 m/s. The wind rose plot (Figure 6-9) for hours 10 A.M. to 6P.M. showed the prevailing wind direction being from the east, with wind speeds between 2.1 to 3.5 m/s and 3.6 to 5.7 m/s, blowing equally at 22% within the east direction.

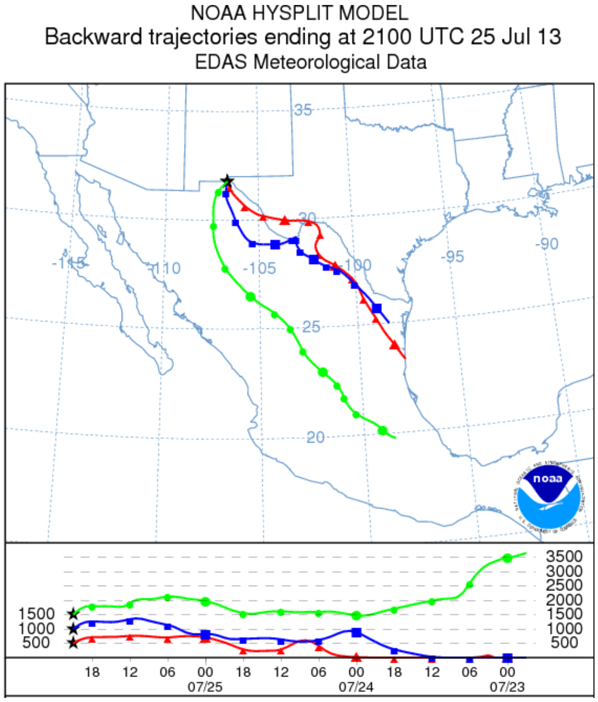


Figure 6-7: July 25, 2013, 72-hour Backward Trajectory at Santa Teresa Monitor.

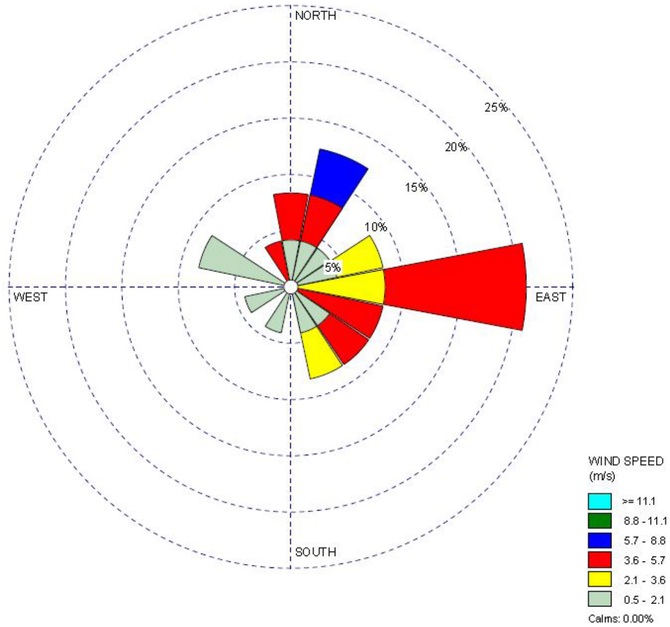


Figure 6-8: July 25, 2013, 24-hour Wind Rose Plot

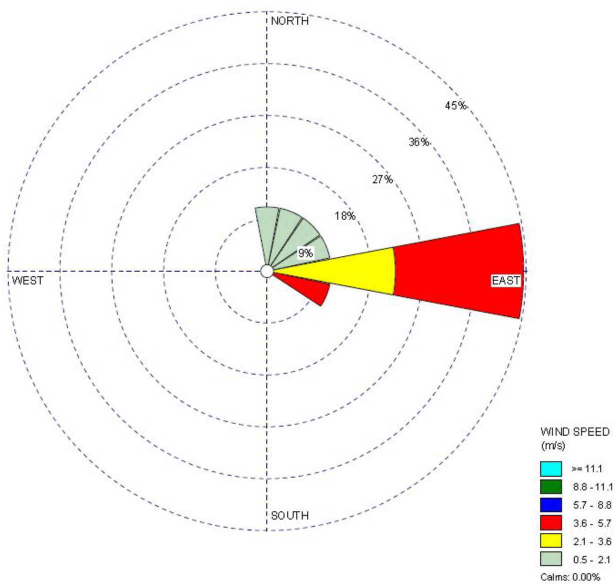


Figure 6-9: July 25, 2013, Wind Rose between 10 A.M. to 6 P.M.

Figure 6-10, for July 27 (the highest ozone day of the 14 ozone day exceedances) showed that the lower trajectory appeared to be under the influence from air masses in northern Texas panhandle region and parts of Oklahoma. It appeared that the air mass was recirculated in this region before moving towards the study area. The backward trajectory approached the region from an easterly wind direction. The 24-hr wind rose plot for July 27 (Figure 6-11) indicated that the surface wind pattern was dominated by easterly winds (i.e. NNE, NE, ENE, E, ESE, SE and SSE directions) at low to light wind speeds. Overall, the winds speeds blew at 33% of the time between 0.5 to 2.1 m/s, 38% at 2.1 to 3.6 m/s, 29% at 3.6 to 5.7 m/s. The 8-hour wind rose (Figure 6-12) showed that all of the winds were wind speeds less than 3.6 m/s from a southeasterly direction.

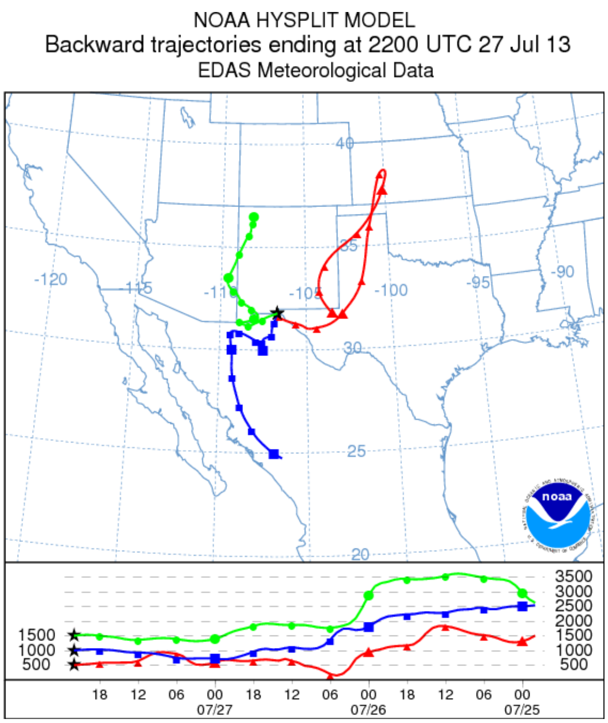


Figure 6-10: July 27, 2013, 72-hour back trajectory at Santa Teresa monitor.

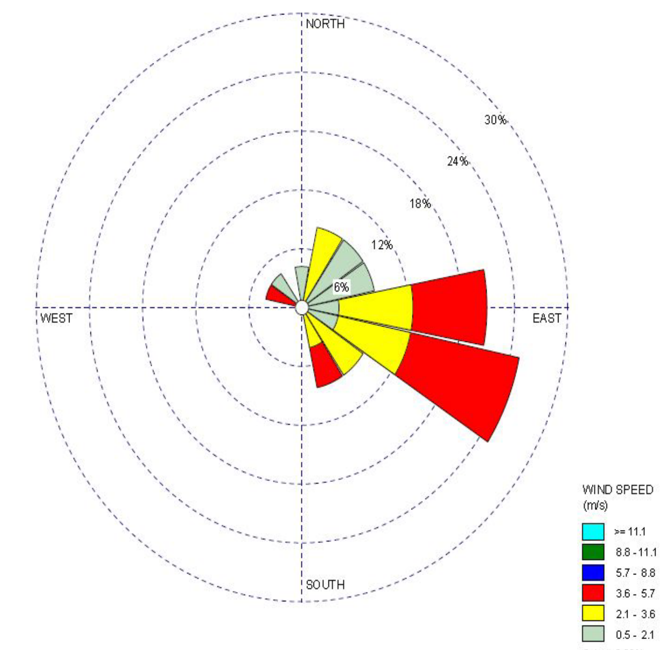


Figure 6-11: July 27, 2013, 24-hour Wind Rose Plot

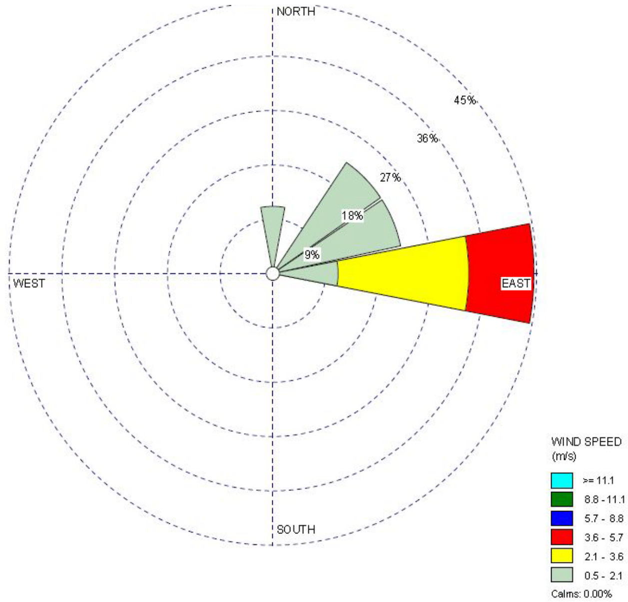


Figure 6-12: July 27, 2013, Wind Rose between 10 A.M. to 6 P.M.

6.4 Summary of HYSPLIT Analysis

Table 6-8 summarizes the results of the 72-hour trajectory cluster analysis for high ozone days for 2006, 2012 and 2013. The region that appeared to be the most significant contributor (at 43%) of transport ozone, at least for the most recent two years, was the Lower Rio Grande Valley and northern Mexican Border States in the SE direction. However, the contribution for 2006 from the southeast regions was probably higher than what was reported in Table 6-8, due to the fact that it appeared that a majority of the trajectories, that were not able to be clustered in the cluster analysis, originated from the SE direction. For 2006 and 2013, approximately 22% of the trajectories that carried long-range transport ozone originated from a SW direction from Mexico's Baja California through the state of Sonora before arriving to the study area. Based on the path of the trajectories through the state of Sonora, the capital city of Hermosillo is more than likely one of the sources that is transporting ozone pollution to the study area due to the number of manufacturing facilities located there that more than likely generate NOx and VOC emissions. Taking a closer look at the individual trajectories from the west (Appendix E, F and G), these trajectories originate either in southern California or Arizona, but appear to pick up ozone pollution from the metropolitan areas of Phoenix and Tucson. The trajectories from the east more than likely pick up transport ozone from the major cities of Dallas, Austin and San Antonio. In 2012, no

trajectories originating from the east were observed. However, looking at the clusters with the individual trajectories (Appendix F) for this year, transport ozone originated from Dallas appears in the NE cluster, while transport ozone from San Antonio could be seen in the SE cluster. Overall, the cluster analysis indicated that transport ozone into the region, originated from a number of metropolitan areas where either mobile sources or industry is significant.

Table 6-8: 72-hour Trajectory Cluster Analysis Summary for 2006, 2012 and 2013

2006			2012			2013		
Cluster Direction	Region	%	Cluster Direction	Region	%	Cluster Direction	Region	%
NW	Northern New Mexico; Utah	4	No Cluster observed in this direction this year			NW	Northern New Mexico; Southern Nevada	7
W	Southern Arizona; Southern California	26	W	Southern Arizona; Southern California	17	W	Southern Arizona	14
SW	Mexico – Baja California & Sonora	22	SW	Mexico – Baja California & Sonora	13	SW	Mexico – Baja California; Sonora	22
NE	Texas Panhandle; Oklahoma; Nebraska	10	NE	Texas Panhandle; Oklahoma; Nebraska	26	NE	Texas Panhandle; Oklahoma; Nebraska	9
E	East Texas	18	No Cluster observed in this direction this year			E	East Texas	6
SE	Lower Rio Grande Valley; Northern Mexican Border States	18	SE	Lower Rio Grande Valley; Northern Mexican Border States	43	SE	Lower Rio Grande Valley; Northern Mexican Border States	42

A total of 14 days exceeded the 8-hour ozone standard in 2013. Eleven out of the 14 days were either from the southeastern, eastern and northeastern directions. The top three exceedances all fell within one of these directions as well.

Backward trajectories were conducted for the top three days (July 3, July 25 and July 27) with the highest daily maximum 8-hour average ozone concentration for the Santa Teresa monitor in 2013. For July 3, July 25 and July 27, transport ozone at the 500 meter trajectories originated from regions to the east, northeast and southeast of the PdN region, respectively. However, all three lower backward trajectories appeared to arrive at the PdN region en route from northern Chihuahua. The 24-hour wind rose for each of the days showed that the prevailing winds were from either the east and/or southeast direction(s). For July 3, July 25 and July 27, winds blew at relatively low wind speeds (less than 3.6 m/s) at 80%, 59% and 71% of the time, respectively. The 8-hour wind rose for each of the days showed that prevailing winds were from either the east and/or southeast direction(s). For July 3, July 25 and July 27, winds blew at relatively low wind speeds (less than 3.6 m/s) at 89%, 66% and 99%, respectively, for much of the time during this 8-hour period.

Chapter 7: Discussion and Conclusions

To date, Doña Ana County has been in attainment of the 8-hour ozone standard. Historically, the air quality monitor that has shown the most ozone exceedances within Doña Ana County and been the monitor of greater concern for regulatory authorities is the 6ZM-Desert View monitoring station, located within Sunland Park, New Mexico. However, the 6ZN-Santa Teresa monitor (located near the Santa Teresa Port of Entry) began to show more exceedances than the Desert View monitor in 2012. Additionally, ozone concentrations for the monitor are such that for regulatory purposes, the monitor could potentially place the County at risk of being in violation of the 8-hour ozone standard of ozone. This ozone study is unique in that it focuses more on the Doña Ana County area versus the larger metropolitan areas of the Paso del Norte Region of El Paso, Texas and Ciudad Juarez, Chihuahua, where the majority of ozone studies are conducted.

The objective of this study was to understand the long term ozone trends in southern Doña Ana County (the study area) by utilizing historical meteorological and air quality data from January 2006 to September 2013 to determine whether increasing ozone concentrations are unique to the area near the 6ZN-Santa Teresa monitor or if this is a problem that the Paso del Norte Region experiences. Second, the study focused on identifying potential local source areas, as well as regional and/or long-range sources of transport ozone that may be contributing to ozone pollution in the study area.

Time series graphs created utilizing the daily maximum 8-hour average ozone concentration for each day from 2006 to 2013, for the five southern Doña Ana County air quality monitors (6ZO-La Union, 6ZK-Chaparral, 6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa) and two El Paso monitors (C12-UTEP and C41-Chamizal) showed that ozone peaks or high ozone days were not unique to one station. Regardless of the locations of these monitors throughout the Paso del Norte region, the monitors all show similar ozone concentration variation or peaks on certain days throughout the year but even more so during the summer months where ozone levels are higher. Additionally, the ozone peaks were not dominated by only one particular monitoring station, but varied between each of the seven stations utilized for this study; therefore, showing that for high ozone days, transport ozone contributed to the whole region, not just one particular location within the air basin.

The wind roses for several monitoring stations (6ZG-Sunland Park, 6ZM-Desert View, 6ZN-Santa Teresa and C12-UTEP) were used as a way to “triangulate” transport ozone from a local source to the study area. A pollution rose analysis was also conducted to determine the frequency of direction in relation to ozone concentrations arriving at the monitoring stations. Wind rose plots from 2006 through 2013 for high ozone days (> 0.06 ppm) for each of the air quality monitors, showed that the prevailing winds were from the east-southeast (ESE) direction, followed by an east (E) or southeast (SE) direction. In addition, the poorest air quality, ozone concentrations greater than 75 ppb, were observed with the prevailing winds coming from the east sector, most specifically from the ESE, SE or E direction.

An overview of local sources of ozone pre-cursors within Doña Ana County in presented in this study. Based on the locations of the point sources identified within Doña Ana County and considering the prevailing winds (SE direction) for each of the monitors, it is likely that emissions from the sources originating in El Paso, Texas and Ciudad Juarez, Chihuahua contribute to the ozone pollution for the study area. Based on the latest emission inventories for Sunland Park, El Paso and Ciudad Juarez, NOx and VOC emissions generated in El Paso and Ciudad Juarez were significantly greater than that from the Sunland Park/Santa Teresa area. Considering the study by ASU and ADEQ, where the major process contributing to ozone formation in El Paso is photochemistry, the study area is more than likely receiving local transport ozone formed from mobile sources and industries located in El Paso and Juarez that emit significant emissions of ozone precursors. The point sources located within the industrial parks in Santa Teresa and Sunland Park, the vehicle traffic associated with the Santa Teresa Port of Entry, Foxconn and Union Pacific Intermodal Rail Facility, are sources potentially contributing to additional NOx and VOC emissions in recent years. Unfortunately, their impacts on air quality to this area have not been studied. However, in terms of ozone pollution, the additional NOx and VOC emissions created from these sources would likely impact areas several miles downwind of these sources, rather than the immediate area of Santa Teresa. Further studies that focus more on modeling the photochemistry from these sources would need to be conducted to conclusively state this.

The NOAA HYSPLIT backward trajectory model with cluster analysis was utilized to identify potential source origins or regions of long-range ozone transport (including ozone precursors) for 2006,

2012 and 2013 (for high ozone days). A 72-hour trajectory cluster analysis for 2006, 2012 and 2013, showed that the region that appeared to be the most significant contributor (at 43%) of transport ozone, for 2012 and 2013, is the Lower Rio Grande Valley and northern Mexican Border States in the SE direction. For 2006 and 2013, approximately 22% of the trajectories (SW direction) that originated in either Mexico's Baja California and traveled through Sonora may carry long-range transport ozone to the study area. Based on the path of the trajectories through the state of Sonora, the capital city of Hermosillo is likely one of the sources for transport ozone entering the study area. The trajectories that originated from the west, in southern California or Arizona, show that ozone from the metropolitan areas of Phoenix and Tucson could be transported into our study region. The trajectories from the east likely picked up transport ozone from the major cities of Dallas, Austin and San Antonio. Overall, the cluster analysis indicated that transport ozone into the region originates from a number of metropolitan areas where either mobile or industrial sources are significantly present.

Finally, backward trajectories were developed for the top three days (July 3, July 25 and July 27) that exceeded the ozone standard at the Santa Teresa monitor for 2013. The 24-hour wind rose for each of the days shows that the prevailing winds were from either the east and/or southeast direction(s). For July 3, July 25 and July 27, winds blew at relatively low wind speeds, less than 3.6 m/s, at 80%, 59% and 71% of the time, respectively. The 8-hour wind rose for each of the days showed that prevailing winds were also from either the east and/or southeast direction(s). For July 3, July 25 and July 27, winds blew at relatively low wind speeds (less than 3.6 m/s) at 89%, 66% and 99% for much of the time during this 8-hour period. For July 3, July 25 and July 27, the lower trajectories originated from an east, northeast and southeast region. It should be noted that along all three 500 meter trajectories, pollution can be picked up from other regions as these trajectories move towards the study area. However, it is beyond the scope of this study to quantify the degree of transport ozone from each region(s) along the trajectories and which is impacting the study area more.

In conclusion, future studies should focus on modeling the photochemistry that is associated with some of the sources identified within the Santa Teresa and Sunland Park area, to get a better understanding of the true impact of these sources on the region's air quality. In particular, considering

that additional NOx and VOC emissions are being generated from increased traffic within the Santa Teresa area (both north and south of the US-Mexico border), it will be important to see what impact these emissions will have on areas downwind of these sources, in order to better address air quality management in Southern Doña Ana County and surrounding counties. To date there is no study that has been conducted in the region that has identified how much of ozone actually is transported from outside the air basin. By quantifying the magnitude of transport ozone entering the PdN region, environmental agency authorities and local stakeholders will be able to make better decisions regarding ozone control strategies for the region. Lastly, emission inventories for both Doña Ana County and Ciudad Juarez should be updated. The last ozone emission inventory for Doña Ana County is based on a baseline year of 2002. Considering that the county is at risk of being in violation of the 8-hour ozone standard, it would be beneficial to see how much emissions these additional sources (identified by this study) may be contributing to ozone pollution in the region. Considering the transport ozone is more than likely traveling from or through Ciudad Juarez, continuing to improve inventory especially regarding point sources will be important for any future planning regarding air quality in either the US or Mexico.

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Appendix A: Figures A1 through A6

Hourly Maximum Average Wait Times for Commercial Traffic at Santa Teresa Port of Entry

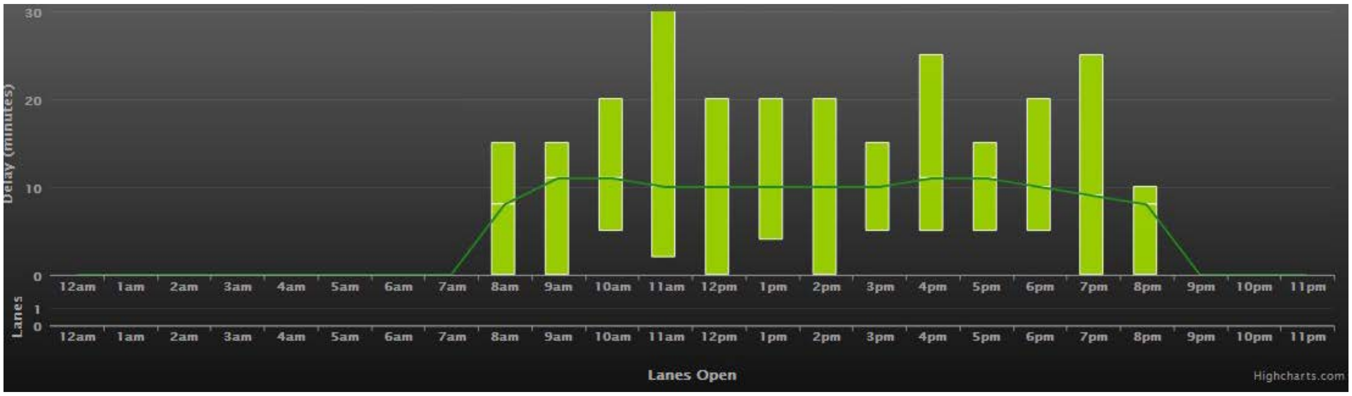


Figure A-1: Monday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 for Northbound Commercial Vehicles (Source: University of California, 2014)

Figure A-2: Tuesday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 for Northbound Commercial Vehicles (Source: University of California, 2014)

Figure A-3: Wednesday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 for Northbound Commercial Vehicles (Source: University of California, 2014)

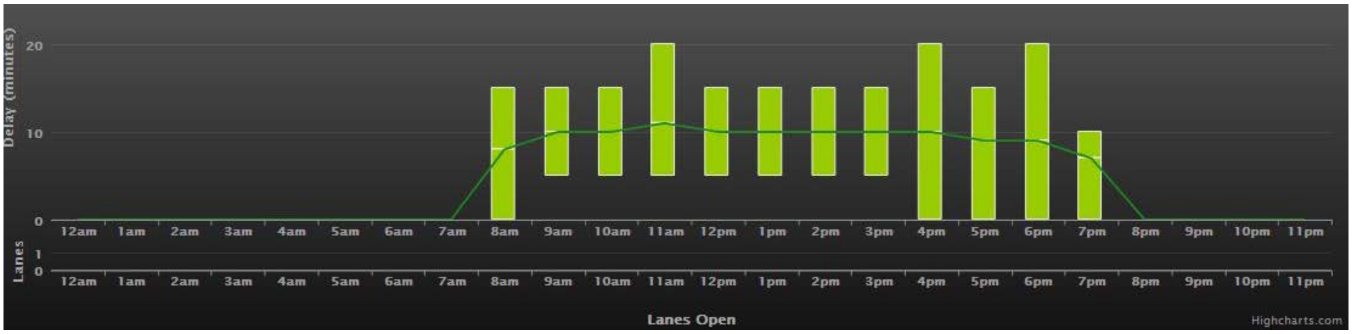


Figure A-4: Thursday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 for Northbound Commercial Vehicles (Source: University of California, 2014)

Figure A-4: Friday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 for Northbound Commercial Vehicles (Source: University of California, 2014)

Figure A-6: Saturday Hourly Average and Maximum Wait Times for Santa Teresa POE for 2014 for Northbound Commercial Vehicles (Source: University of California, 2014)

Appendix B: Tables B-1 through B-8

High Ozone Days for stations for 2006-2013: 6ZN-Santa Teresa (ST), 6ZM-Desert View (DV), 6ZG-Sunland Park (SP), C12-UTEP (UT)

2006 Ozone Season: May 1 – May 31

May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST		X				X	X	X	X	X	X	X	X	X	X	X	X		X	X	X										X
DV						X	X	X		X	X	X		X	X	X	X		X												
SP				M		X		X		X				X			X														
UT						X		X		X		X		X		X	X		X	X	X										

2006 Ozone Season: June 1 – June 30

June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST	X	X	X	X	X							X	X			X	X	X	X			X		X	X	X	X	X	X	X
DV		X	X	X	X	X			X	X		X	X			X	X	X	X	X		X		X	X	X	X	X	X	X
SP			M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		X					X	X	X	X
UT		X	X	X	X	X			X	X		X	X			X	X	X	X	X		X		X	X	X	X	X	X	X

2006 Ozone Season: July 1 – July 31

July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST	X	X	X	X	X		X	X	X		X			X		X			X	X			X	X			X	X			
DV	X	X	X	X	X		X		X	X	X			X									X	X	X	X	X	X			
SP	X		X	X					X		X												X	X		X	X	X			
UT	X	X	X	X	M	M	M	X	X	X	X	M	X	X									X	X	X	X	X	X	X		M

2006 Ozone Season: August 1 – August 31

Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST								X												X			X				X				
DV																							X				X			M	M
SP																							X				X				
UT	M	M	M	M	M	M	M						X					X		X			X			X	X				

2006 Ozone Season: September 1 – September 30

Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST											X																			
DV						X																								
SP																														
UT		M	M	M	M	M	M																							

Table B-1 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

2007 Ozone Season: May 1 – May 31

May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST										X	X	X	X	X				X	X												
DV										X	X	X	X	X					X												
SP										X		X							X												
UT								M		X	X	X	X						X												

2007 Ozone Season: June 1 – June 30

June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST		X		X						X				X	X	X					X						X	X		
DV		X		X	X					X				X		X					X			X				X	X	
SP		X		X						X				X		X					X							X		
UT		X		X	X					X			X	X		X					X			X				X	X	X

2007 Ozone Season: July 1 – July 31

July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST	X		X													X															
DV	X	X	X					X		X				X	X	X	X									X					
SP		X	X												X	X															
UT	X	X	X				X	X	X	X				X	X	X	X									X					

2007 Ozone Season: August 1 – August 31

Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST															X	X					M	M	M	M	M	M	M	M	M		
DV										X				X	X	X				M	X			M							
SP															X					M											
UT						M				X					X	X		X											M	M	M

2007 Ozone Season: September 1 – September 30

Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST				X																		X								
DV				X								X		X								X								
SP				X								X																		
UT				X				X			M	M	M	M	M	M	M													

Table B-2 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

2008 Ozone Season: May 1 – May 31

May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST		X	X	X						M				X																	
DV		X	X	X										X																	
SP														X																	
UT		M	M	M	M	M	M							X																	

2008 Ozone Season: June 1 – June 30

June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST					X	X			X					X								X								
DV					X	X			X				X	X			X					X								
SP									X					X			X					X								
UT									X				X	X			X	X				X								

2008 Ozone Season: July 1 – July 31

July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST	X												X																		X
DV	X																				X	X									X
SP																						X									X
UT														X							X	X									X

2008 Ozone Season: August 1 – August 31

Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST	X	X		X		X	X	X				X	X						X												
DV				X		X	X	X			X	X	X						X			X									
SP				X		X																					M				
UT	X		X	M		X	X	X			X	X	X				X		X			X									

2008 Ozone Season: September 1 – September 30

Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST			X		X			X																						
DV					X	X		X																						
SP					X																									
UT				X	X														X											

Table B-3 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

2009 Ozone Season: May 1 – May 31																															
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST									X		X							X										X	X		
DV									X		X										M		X		M			X			
SP																															
UT									X		X												X					X			

2009 Ozone Season: June 1 – June 30																														
June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST			X																											
DV			X																											
SP																														
UT			X																										X	

2009 Ozone Season: July 1 – July 31																															
July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST																						X		X							
DV																								X		X		X			X
SP																															
UT																								X	X	X					X

2009 Ozone Season: August 1 – August 31																															
Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST			X	X																X									X		
DV			X	X						X										X									X	X	
SP			X							X																			X		
UT			X							X									M	X									X		

2009 Ozone Season: September 1 – September 30																														
Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST													X																	
DV													X								M									
SP									X				X										M							
UT													X												M	M	M	M		

Table B-4 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

2010 Ozone Season: May 1 – May 31																															
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST												X										X						X			
DV												X										X						X			
SP												X										X						X			
UT												X																			

2010 Ozone Season: June 1 – June 30																														
June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST																												X		
DV						X								X																
SP							X							X	X															
UT							X																X							

2010 Ozone Season: July 1 – July 31																															
July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST													X						X												
DV													X					X	X												
SP													X		X			X	X	X											
UT													X		X			X	X	X											

2010 Ozone Season: August 1 – August 31																															
Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST						X					X															X					
DV				X		X				X	M	X		X						X	X	X	X			X	X				
SP				X						X										X			X								
UT			X							X										X	X										

2010 Ozone Season: September 1 – September 30																														
Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST				X																								X		
DV		X		X																								X		
SP				X																										
UT						X																								

Table B-5 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

2011 Ozone Season: May 1 – May 31

May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST	X		X	X	X	X	X	X			X		X	X						X				X	X						
DV	X		X	X		X		X			X		X	X										X	X	X					
SP																								X	X	M					
UT																								X	X						

2011 Ozone Season: June 1 – June 30

Jun	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST				X	X									M								X	X			X	X			
DV	M	M	M	X	X										X						X	X	X			X	X			
SP	M			X		M									X	M	M					X	X			X	X			
UT				X	X																	X	M		X	X	X			

2011 Ozone Season: July 1 – July 31

July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST							X	X	X	X		X			X								X					X	X		
DV							X	X	X	X	X	X	X		X					X		X			X			X	X		
SP							X	X				X	X		X					X					X			X	X		
UT							X	X	X		X	X	X	X	X					X	M	M	M	M	M	M	M	M	M	M	M

2011 Ozone Season: August 1 – August 31

Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST			X	X		X												X	X			X	X				X	X			
DV		X	X	X	X	X		X										X	X		X	X	X			X	X	X		X	M
SP		X	X	X	X	X		X										X	X		X	X	X				X	X		X	
UT	M	M	M	M	M	X		X										X	X		X	X	X			X	X	X		X	

2011 Ozone Season: September 1 – September 30

Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST		X				X			X	X	X	X							X				X							
DV	M	M	M	M	M	M	M	M	M	M	M	M							X				X							
SP			X							X	X	X																		

Table B-6 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

2012 Ozone Season: May 1 – May 31

May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST									M		X	X	X	X	X	X				X	X	X							X	X	X
DV											X	X	X	X	X	X				X	X	X						X	X	X	X
SP		X			X	X					X	X	X	X	X	X	X			X	X	X						X	X	X	X
UT	M										X	X	X	X	X	X	X			X	X	X									X

2012 Ozone Season: June 1 – June 30

June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST	X	X	X	X																X			X	X	X			X	X	X
DV	X	X	X																	X				X	X	X		X	X	X
SP	X	X	X		X	M														X				X	X			X	X	X
UT	X	X	X																	X				X	X			X	X	X

2012 Ozone Season: July 1 – July 31

July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST								X	X	X	X	X	X	X	X			X													
DV									X	X	X	X	X	X	X		X	X		X						X				X	
SP									X	X		X	X	X	X		X	X								X				X	
UT								X	X	X		X	X	X	X		X	X					X							X	

2012 Ozone Season: August 1 – August 31

Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST							X		X	X	X			M	X	X	X		X	X	X	X						X	X	X	X
DV				X			X		X	X	X	X				X	X			X	X				M	M	M	M	M	X	X
SP				X			X		X	X	X	X				X	X			X	X	X							X	X	X
UT				X			X		X	X	X	X			X	X	X		X	X	X	X							X	X	X

2012 Ozone Season: September 1 – September 30

Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST	X	X							X						X			X	X			X	X							
DV	X	X								X					X							X								
SP	X	X								X					X							X								
UT	X	X				X				X					X		M					X		M			M	M	M	M

Table B-7 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

2013 Ozone Season: May 1 – May 31

May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST	X			X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	M		M
DV	X			X	X																								M	M	M
SP																															
UT				X	X							X	X	X			X	X	X				X	X							

2013 Ozone Season: June 1 – June 30

June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST	X					X	X	X	X	X	X	X		X	X			X	X			X				X	X	X	X	X
DV	M	M	M	M			X		X	X	X			X	X			X									X			
SP									X	X	X																X			
UT	X						X		X	X	X			X	X			M		M				M			X		X	

2013 Ozone Season: July 1 – July 31

July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X
DV		X	X	X	X	X	X						X			X						M		M	X		X			X	X
SP			X																												
UT		X	X	X	X	M	M	M	M	M			X	X		M									X		X			X	X

2013 Ozone Season: August 1 – August 31

Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ST		X	X	X	X	X		X	X		X	X		X	X	X	X	X	X	X	X	X				X		M			
DV				X					X			X				X	X	X	X	X	X			M	M	M	M				
SP	M	M														X	X														
UT				X					X			X			X	X	X	X	X	X	X										M

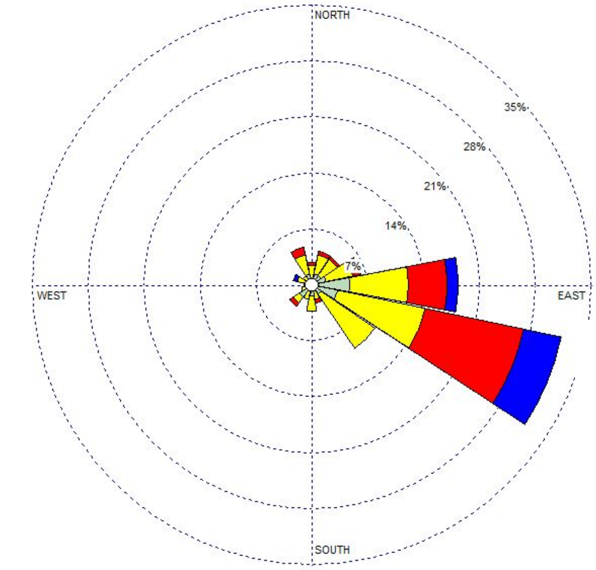
2013 Ozone Season: September 1 – September 30

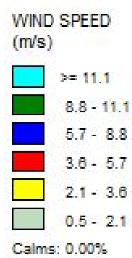
Sept	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ST	X	X	X		X	X		X						X										X						
DV																				M										
SP																														
UT	X																													

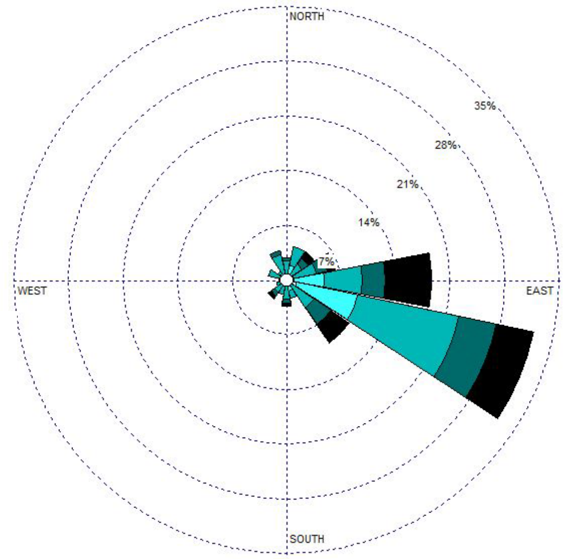
Table B-8 May 1, 2013 – September 30, 2013 Ozone Season indicating ozone days > 0.06 ppm. (Note: "X" denotes Ozone Days > 0.06 ppm. "M" denotes days that did not have a Daily 8-hour maximum ozone concentration value. Blue highlighted days indicate those days that were non-high ozone days for all 4 stations and which were removed from Hysplit runs.)

Appendix C: Figure C-1 through C-40

Ozone Season 2007 – 2011 Wind and Pollution Roses for stations: 6ZN-Santa Teresa (ST), 6ZM-Desert View (DV), 6ZG-Sunland Park (SP), C12-UTEP (UT)

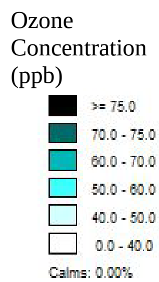


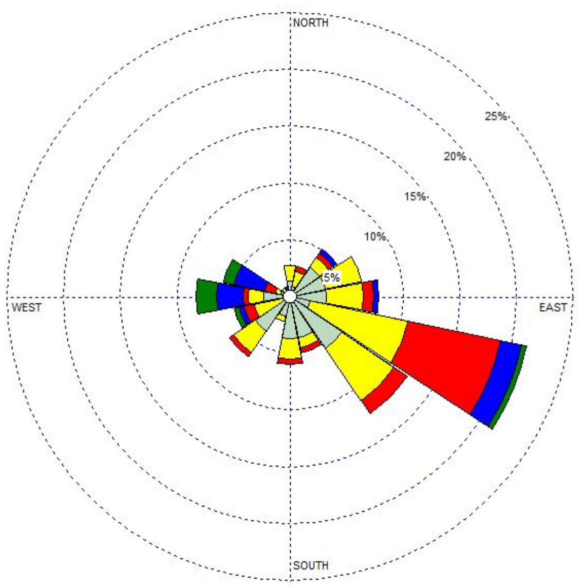


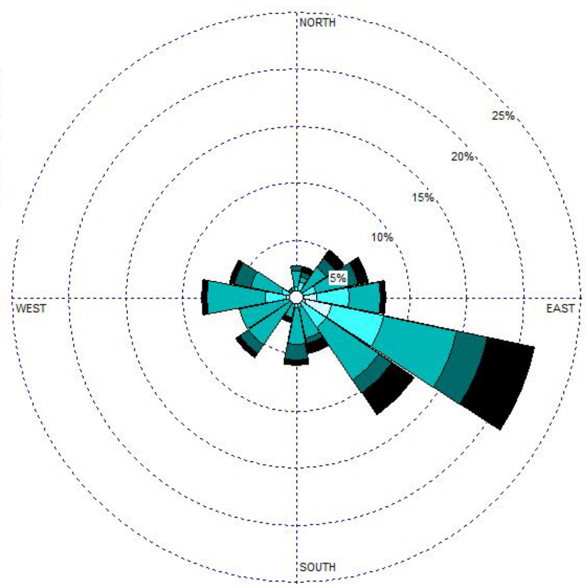


C-1: 2007 Wind Rose Santa Teresa

C-2: 2007 Ozone Pollution Rose Santa Teresa

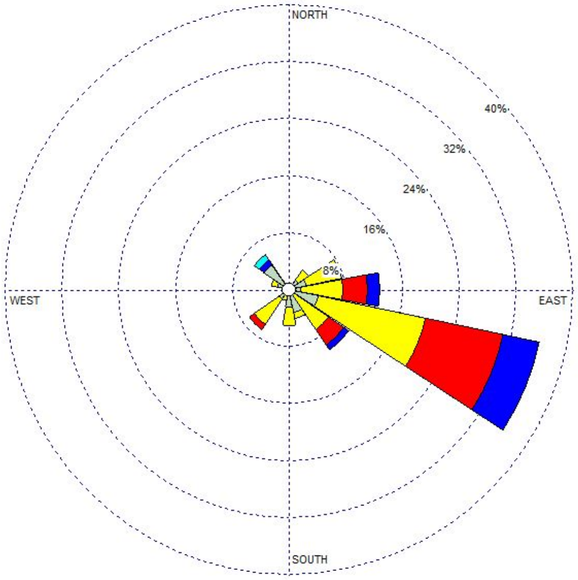




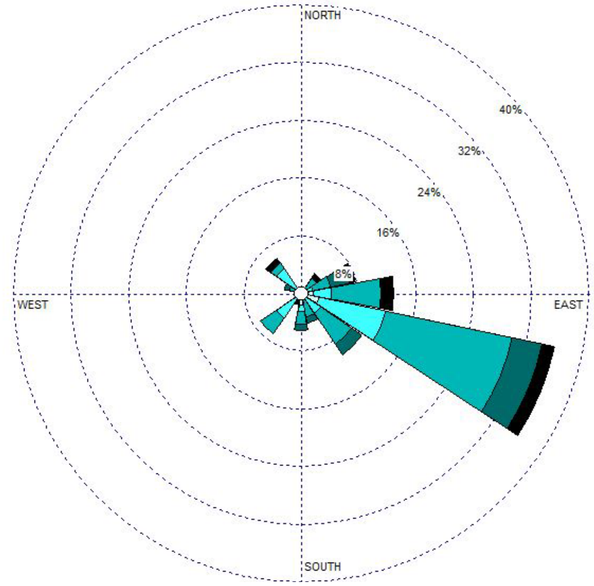


C-3: 2008 Wind Rose Santa Teresa

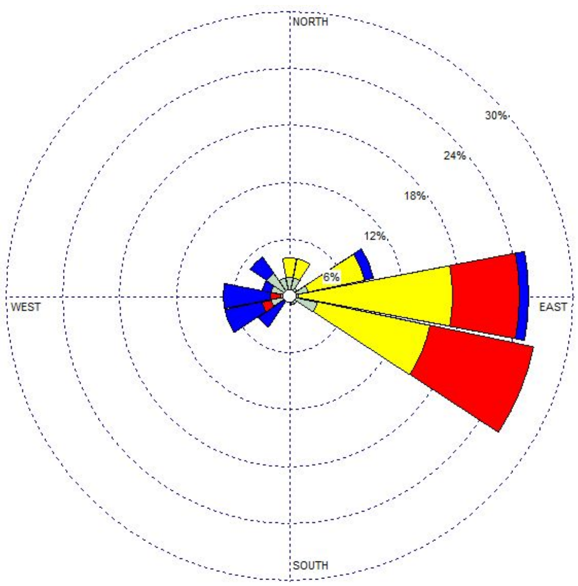
C-4: 2008 Ozone Pollution Rose Santa Teresa



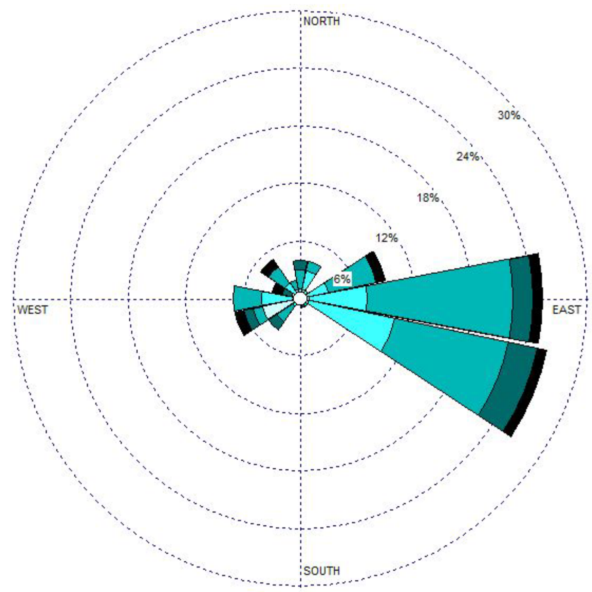
C-5: 2009 Wind Rose Santa Teresa



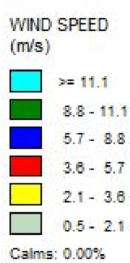
C-6: 2009 Ozone Pollution Rose Santa Teresa



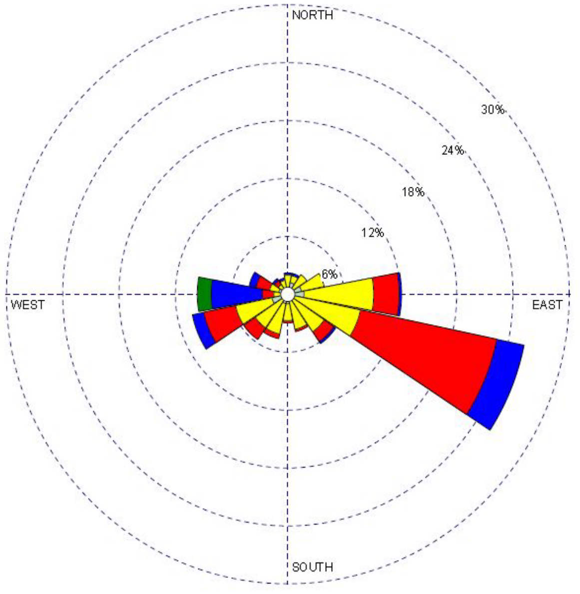
C-7: 2010 Wind Rose Santa Teresa



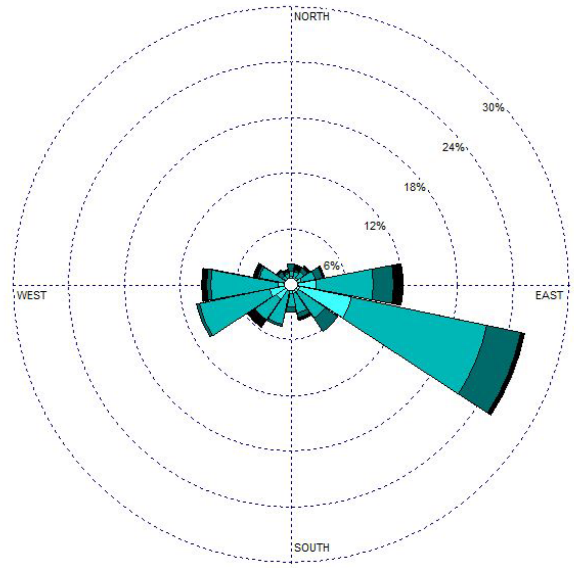
C-8: 2010 Ozone Pollution Rose Santa Teresa



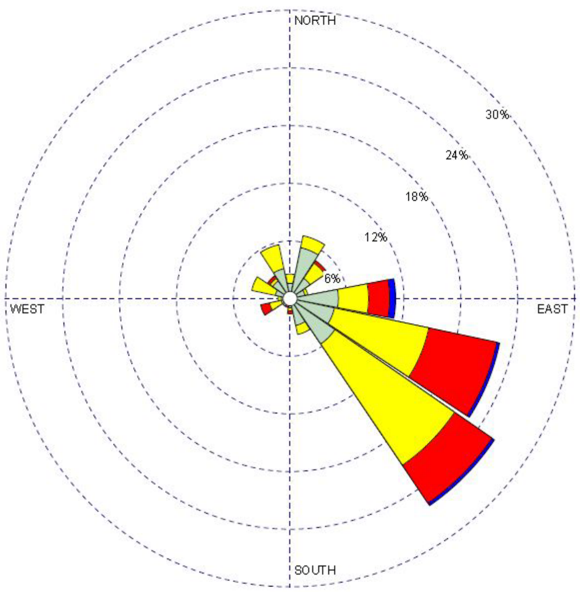
Ozone
Concentration
(ppb)



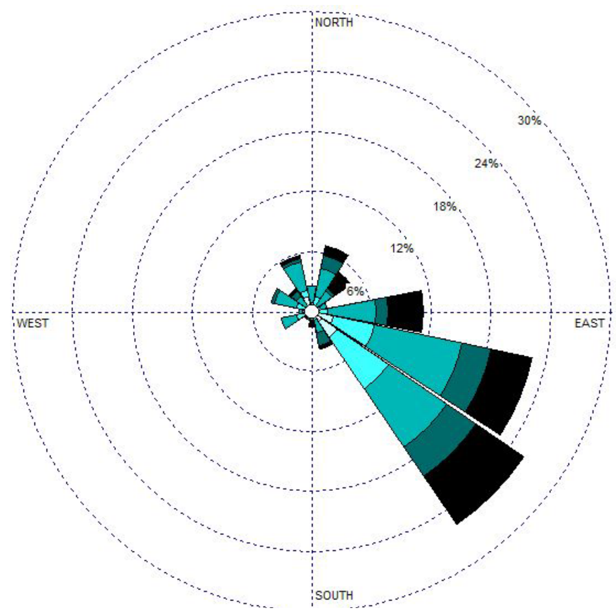
C-9: 2011 Wind Rose Santa Teresa



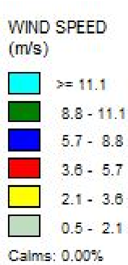
C-10: 2011 Ozone Pollution Rose Santa Teresa

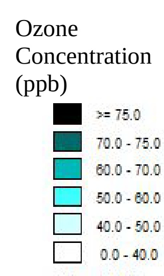


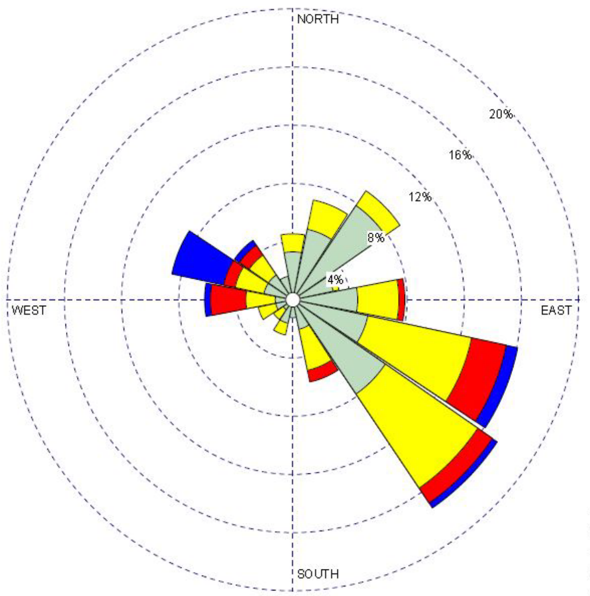
C-11: 2007 Wind Rose Desert View



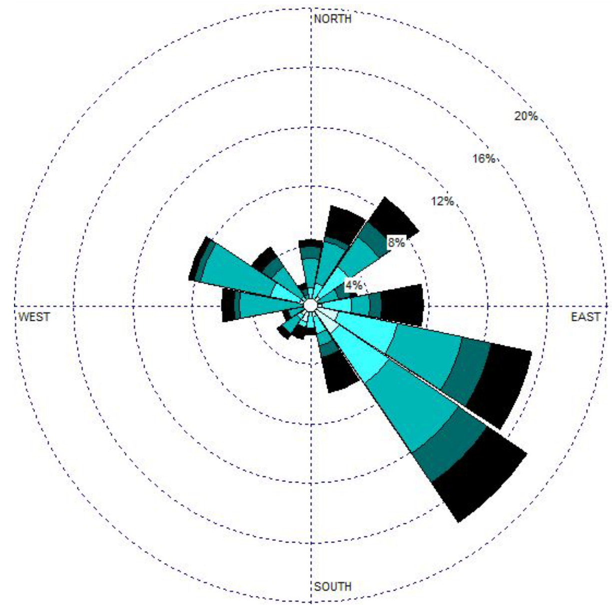
C-12: 2007 Ozone Pollution Rose Desert View



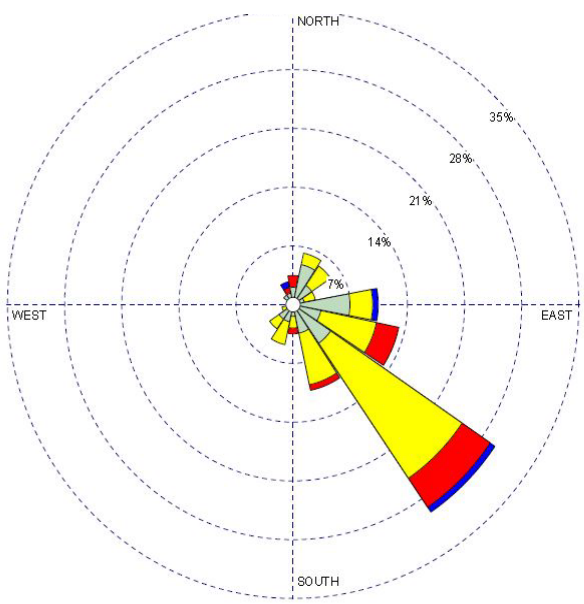




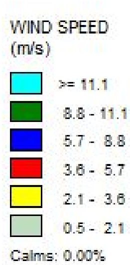
C-13: 2008 Wind Rose Desert View

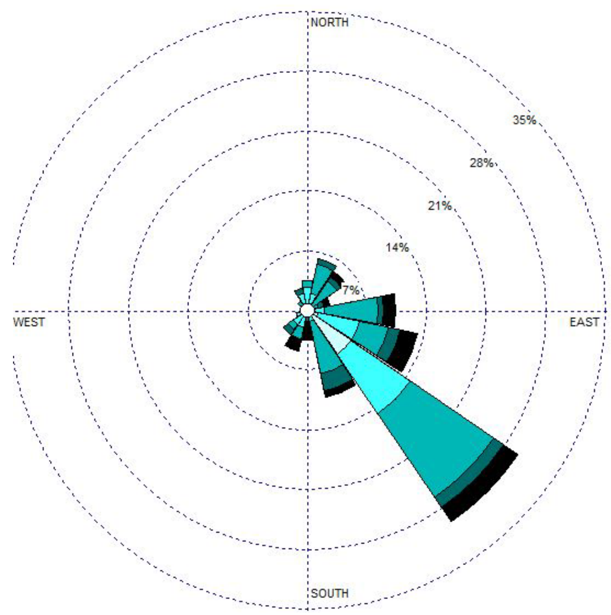


C-14: 2008 Ozone Pollution Rose Desert View

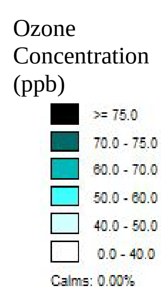


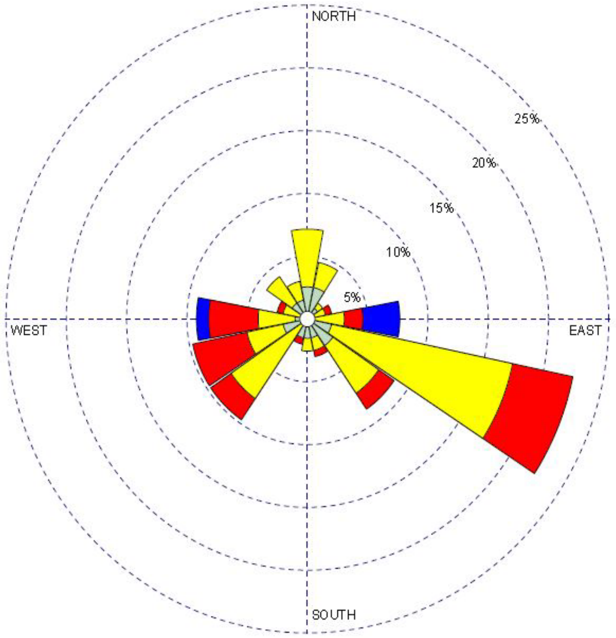
C-15: 2009 Wind Rose Desert View



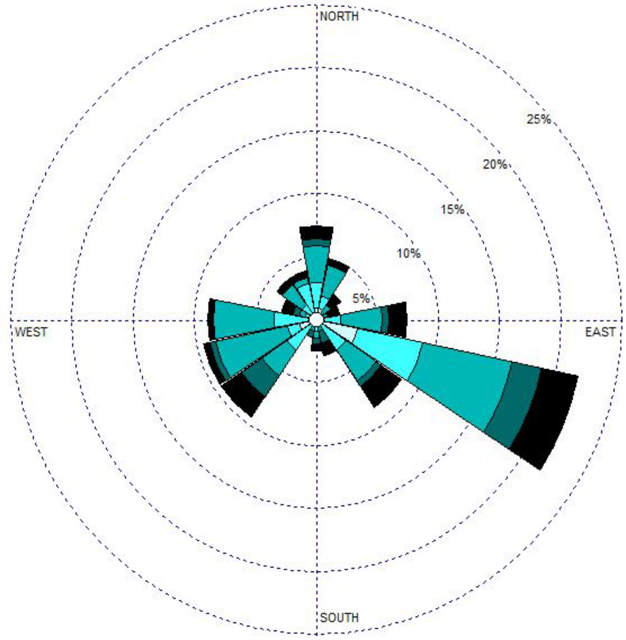


C-16: 2009 Ozone Pollution Rose Desert View

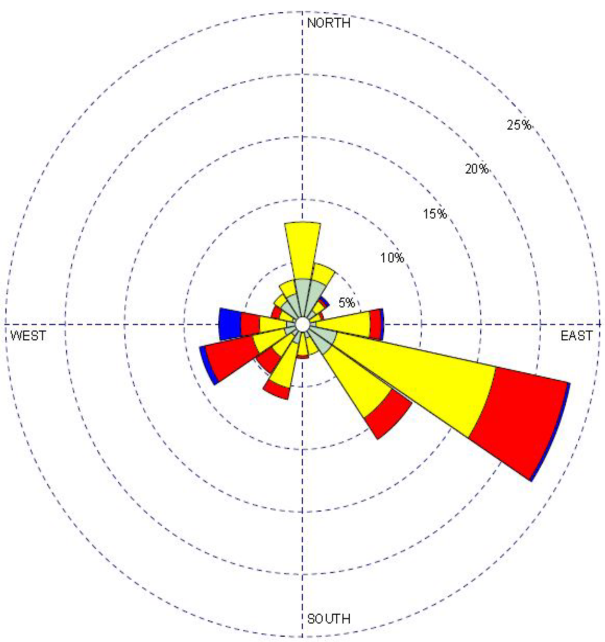




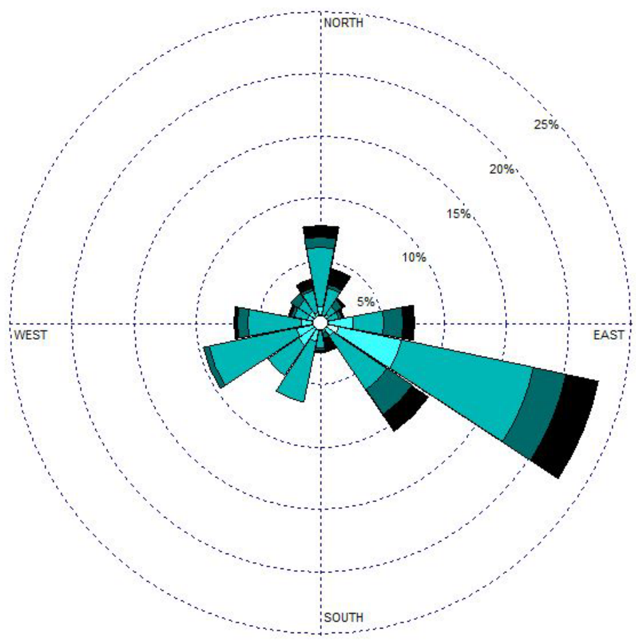
C-17: 2010 Wind Rose Desert View



C-18: 2010 Ozone Pollution Rose Desert View



C-19: 2011 Wind Rose Desert View



C-20: 2011 Ozone Pollution Rose Desert View

WIND SPEED
(m/s)

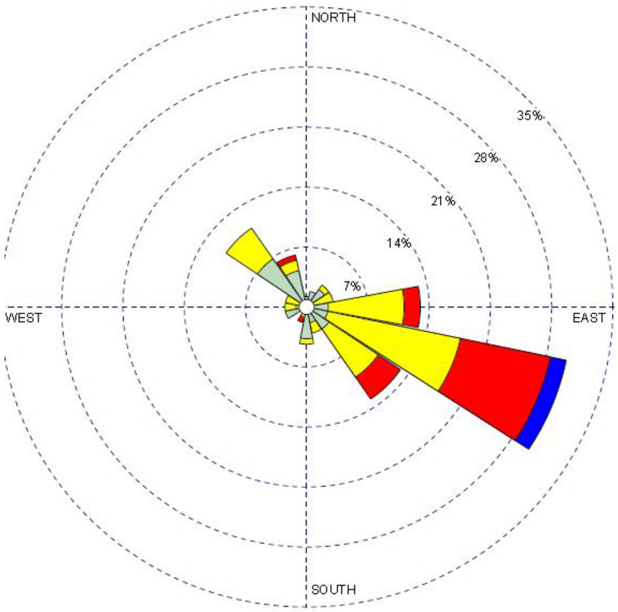
- >= 11.1
- 8.8 - 11.1
- 5.7 - 8.8
- 3.6 - 5.7
- 2.1 - 3.6
- 0.5 - 2.1

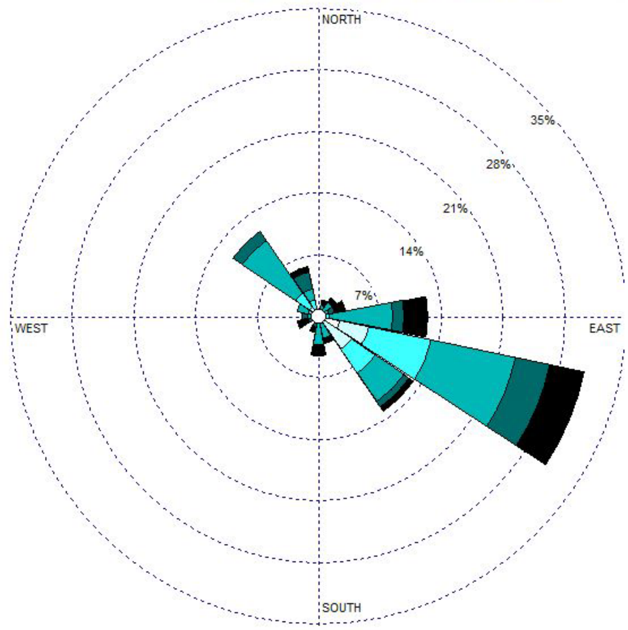
Calms: 0.00%

Ozone
Concentration
(ppb)

- >= 75.0
- 70.0 - 75.0
- 60.0 - 70.0
- 50.0 - 60.0
- 40.0 - 50.0
- 0.0 - 40.0

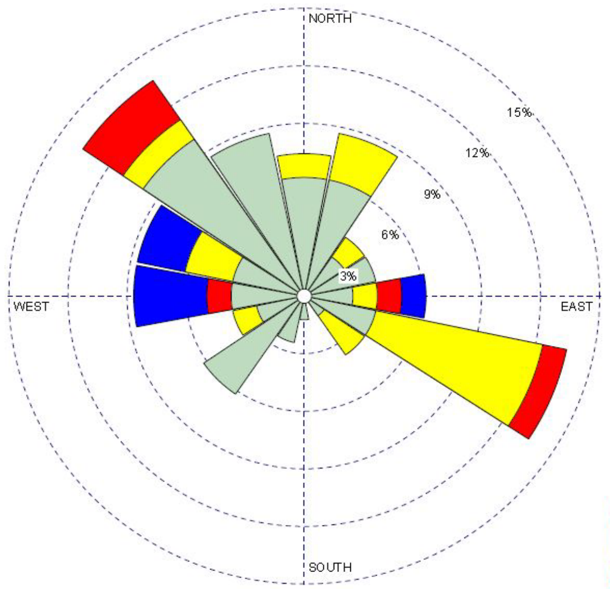
Calms: 0.00%

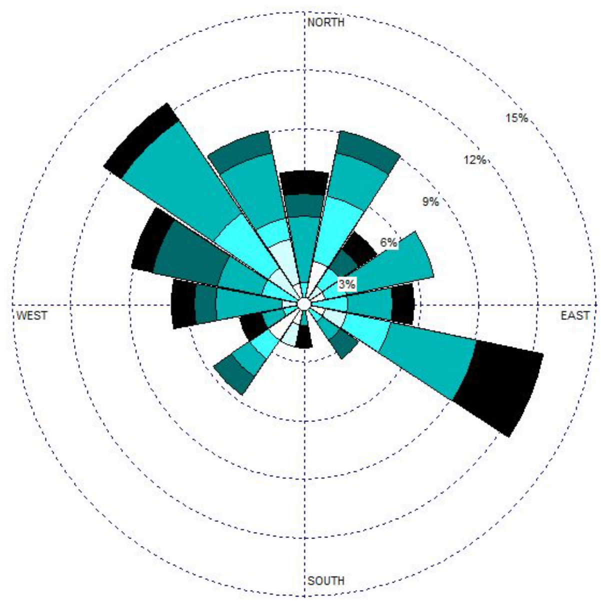




C-21: 2007 Wind Rose Sunland Park

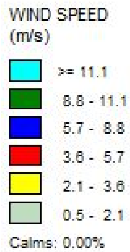
C-22: 2007 Ozone Pollution Rose Sunland Park



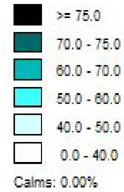


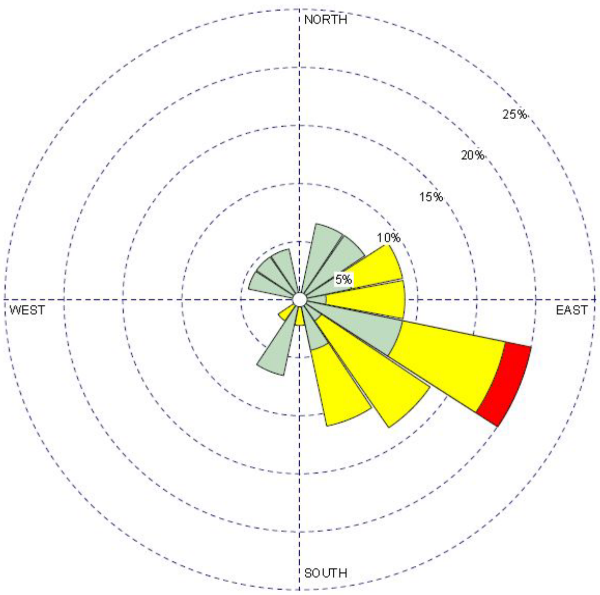
C-23: 2008 Wind Rose Sunland Park

C-24: 2008 Ozone Pollution Rose Sunland Park

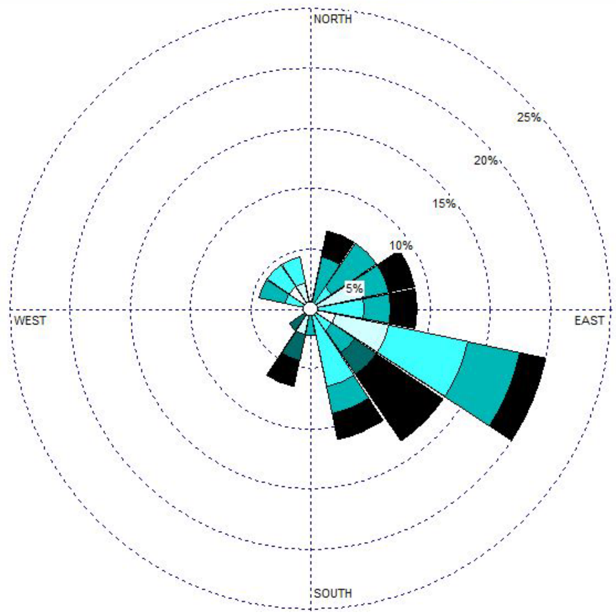


Ozone
Concentration
(ppb)

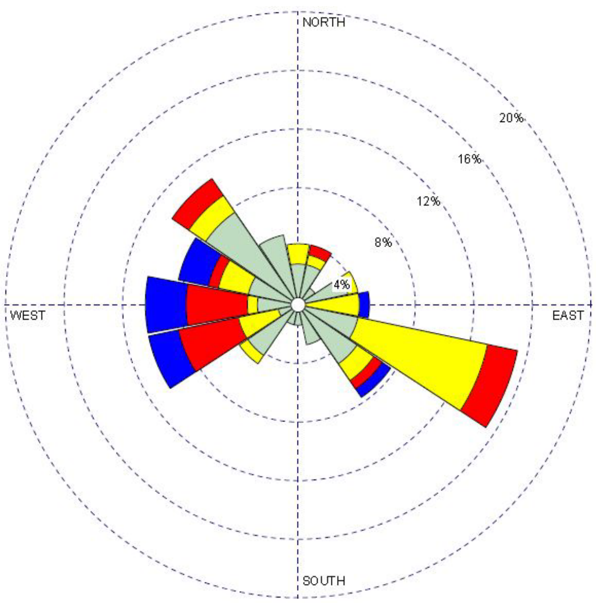




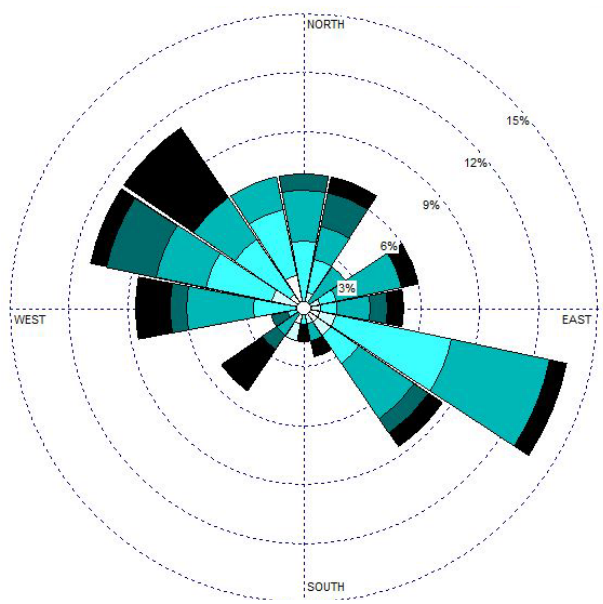
C-25: 2009 Wind Rose Sunland Park



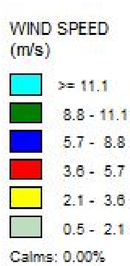
C-26: 2009 Ozone Pollution Rose Sunland Park

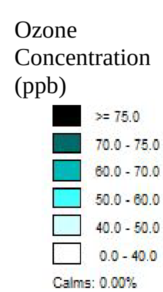


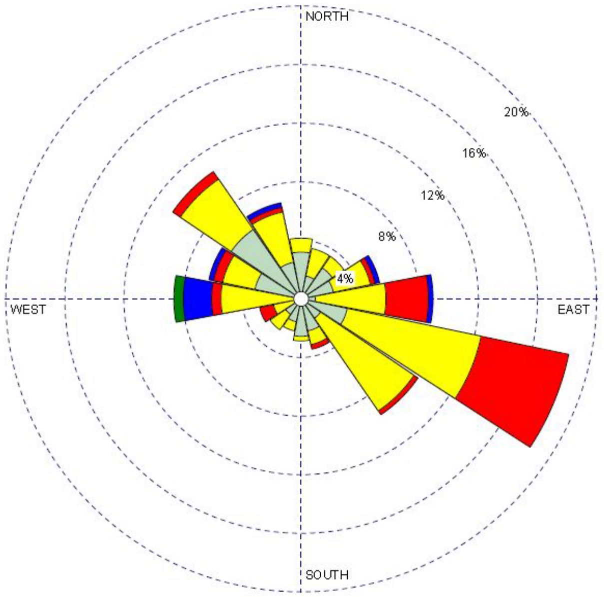
C-27: 2010 Wind Rose Sunland Park



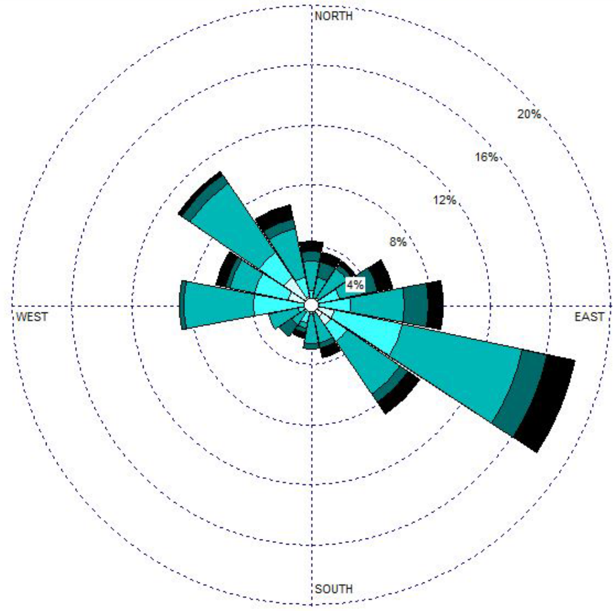
C-28: 2010 Ozone Pollution Rose Sunland Park



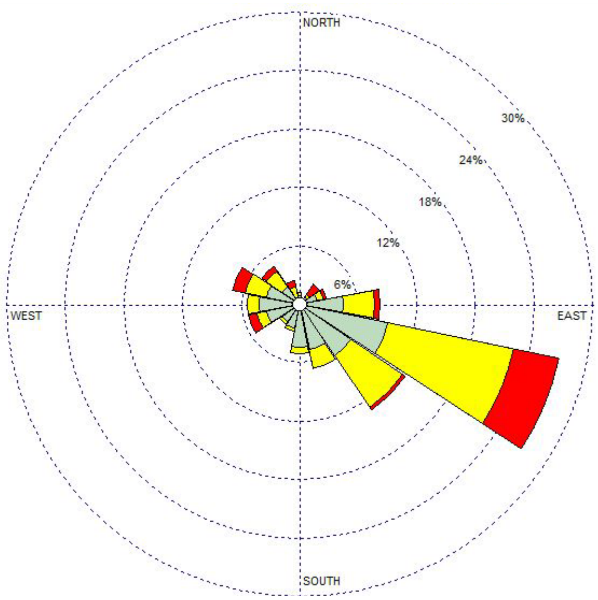




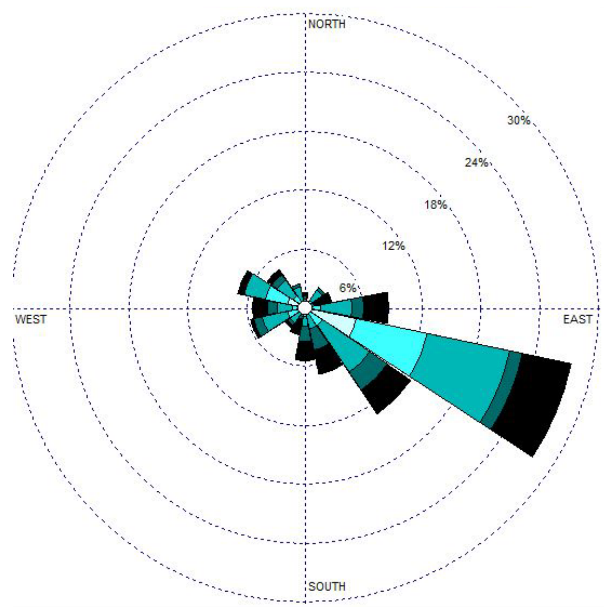
C-29: 2011 Wind Rose Sunland Park



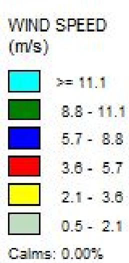
C-30: 2011 Ozone Pollution Rose Sunland Park

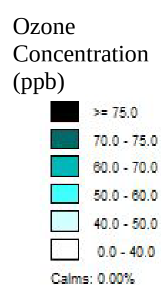


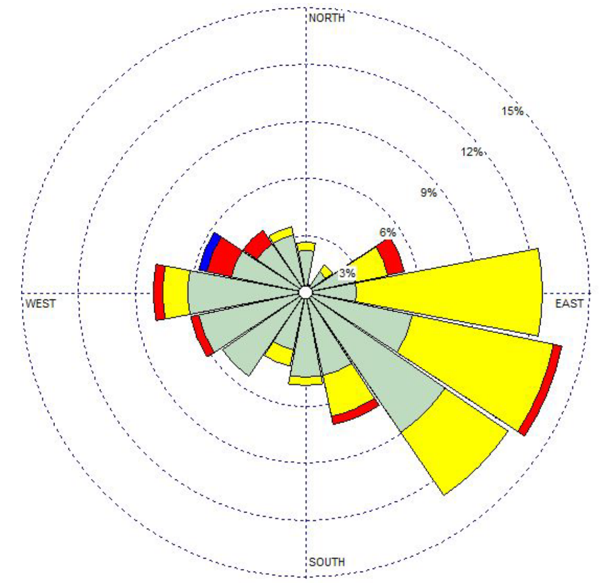
C-31: 2007 Wind Rose UTEP



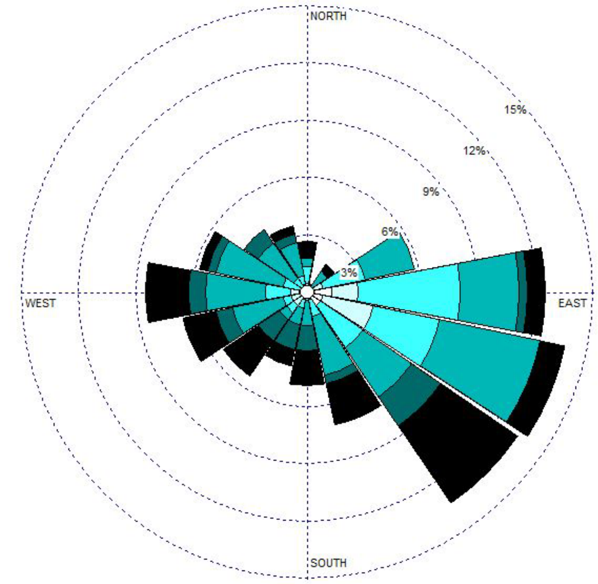
C-32: 2007 Ozone Pollution Rose UTEP



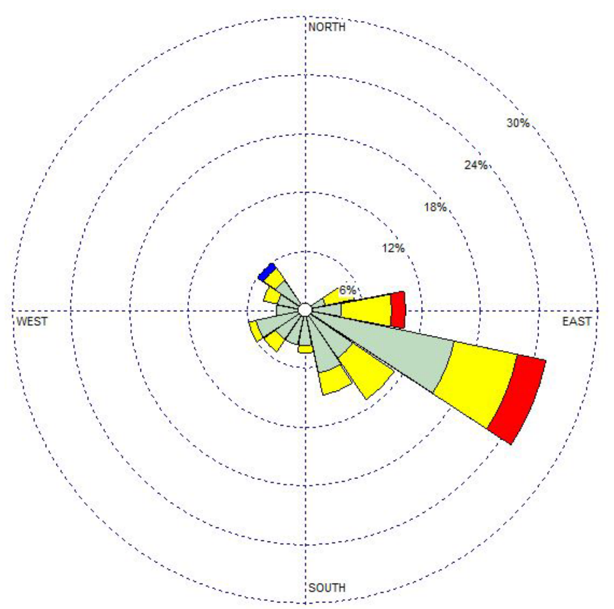




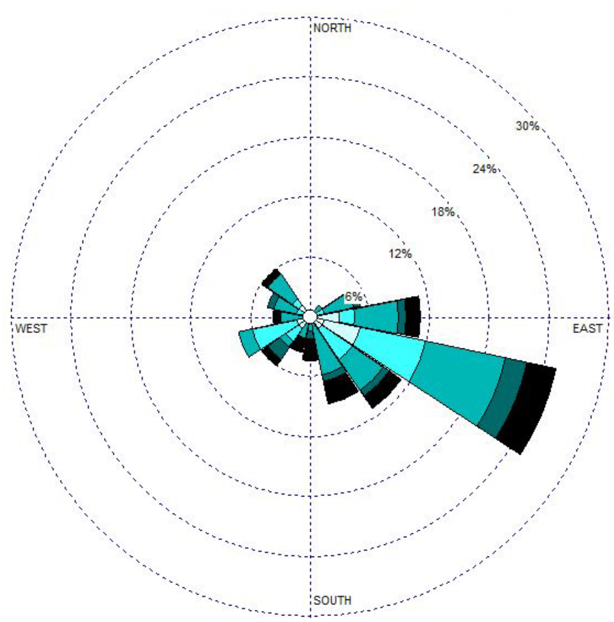
C-33: 2008 Wind Rose UTEP



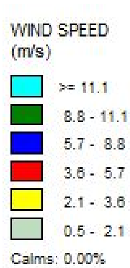
C-34: 2008 Ozone Pollution Rose UTEP

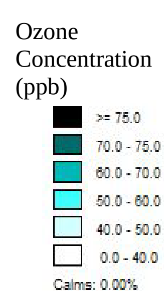


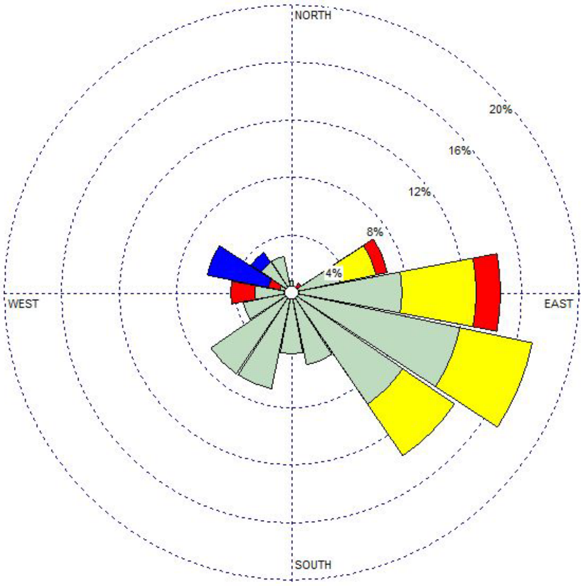
C-35: 2009 Wind Rose UTEP



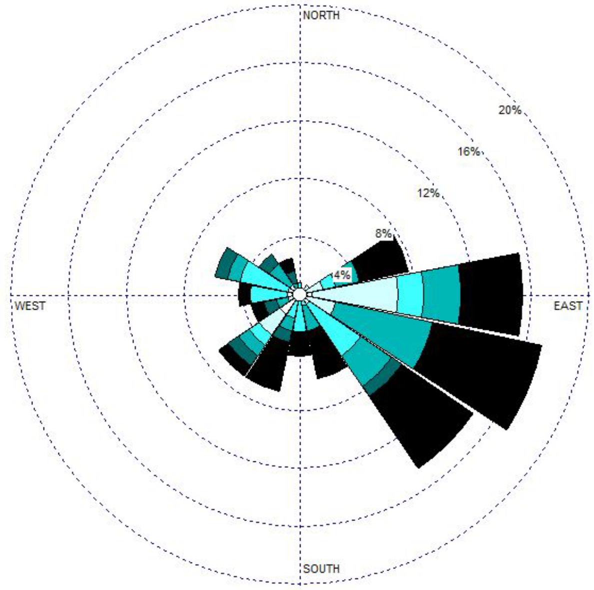
C-36: 2009 Ozone Pollution Rose UTEP



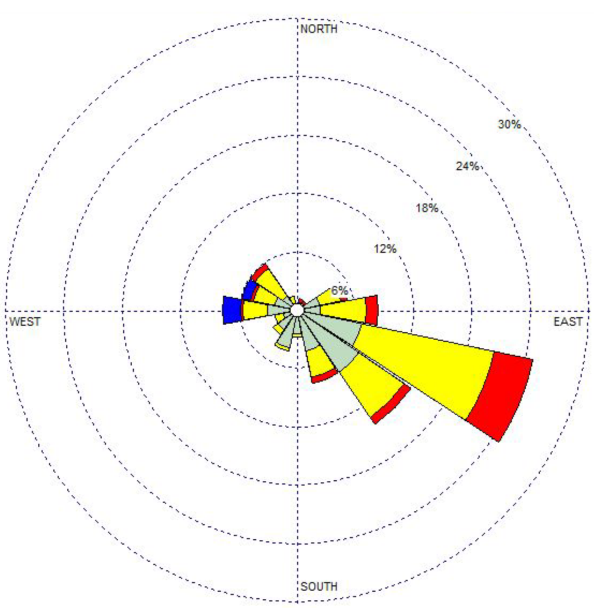




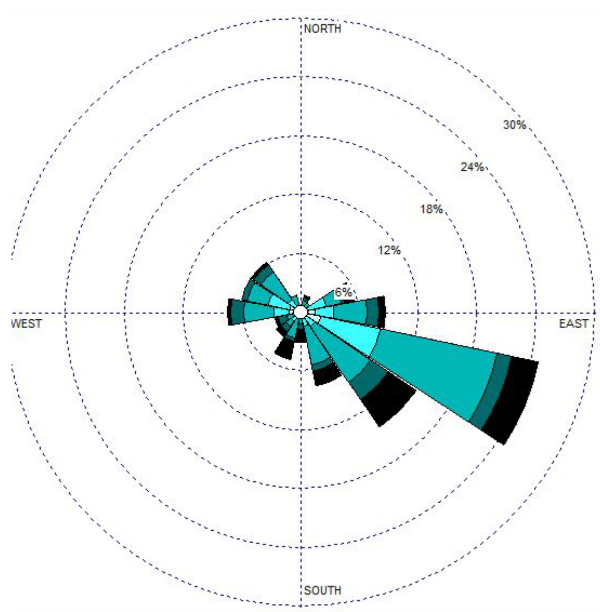
C-37: 2010 Wind Rose UTEP



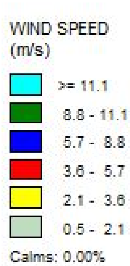
C-38: 2010 Ozone Pollution Rose UTEP

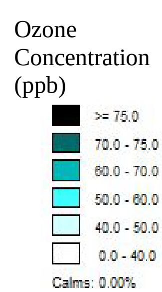


C-39: 2011 Wind Rose UTEP



C-40: 2011 Ozone Pollution Rose UTEP





Appendix D: Frequency Distribution of Wind Direction and Speed; Frequency Distribution of Wind Direction and Ozone Concentration

Table D-1: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Santa Teresa Monitoring Station for 2006

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	0.2	0.8	0.4	0.0	0.0	0.0	1.3
NNE	1.0	0.2	0.0	0.0	0.0	0.0	1.1
NE	1.3	0.8	0.0	0.2	0.0	0.0	2.3
ENE	1.9	2.7	0.4	0.2	0.0	0.0	5.2
E	2.1	5.9	5.9	1.7	0.4	0.0	16.1
ESE	1.0	9.2	12.1	5.4	1.0	0.0	28.5
SE	1.7	4.2	1.9	0.4	0.2	0.0	8.4
SSE	1.0	2.3	1.0	1.0	0.0	0.0	5.2
S	0.6	2.3	0.2	0.0	0.0	0.0	3.1
SSW	1.1	4.2	0.6	0.0	0.0	0.0	5.9
SW	0.6	0.8	0.4	0.2	0.0	0.0	1.9
WSW	0.2	0.4	1.9	2.5	0.0	0.0	5.0
W	0.8	1.3	1.7	3.3	0.0	0.0	7.1
WNW	1.0	1.7	1.5	0.4	0.0	0.0	4.6
NW	0.2	1.7	0.4	0.2	0.0	0.0	2.5
NNW	0.4	0.8	0.6	0.0	0.0	0.0	1.7
Sub-Total	14.9	39.3	28.9	15.3	1.5	0.0	100.0

Table D-2: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Santa Teresa Monitoring Station for 2012

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	0.4	0.4	0.0	0.0	0.0	0.0	0.8
NNE	1.8	1.4	0.6	0.0	0.0	0.0	3.8
NE	0.8	0.8	0.8	0.0	0.0	0.0	2.4
ENE	0.0	2.2	1.0	0.0	0.0	0.0	3.2
E	0.6	3.4	6.7	0.8	0.0	0.0	11.5
ESE	1.4	10.5	18.4	3.6	0.0	0.0	33.9
SE	0.8	6.3	5.5	0.2	0.0	0.0	12.7
SSE	1.0	4.4	0.4	0.0	0.0	0.0	5.9
S	2.0	3.2	0.0	0.0	0.0	0.0	5.3
SSW	0.8	2.2	0.0	0.0	0.0	0.0	3.0
SW	0.8	0.8	0.2	0.0	0.0	0.0	1.8
WSW	1.6	0.4	0.2	0.6	0.0	0.0	2.8
W	1.4	0.4	3.0	2.4	0.0	0.0	7.3
WNW	0.8	0.4	0.8	1.2	0.0	0.0	3.2
NW	0.4	0.4	0.0	0.0	0.0	0.0	0.8
NNW	1.2	0.2	0.0	0.0	0.0	0.0	1.4
Sub-Total	16.0	37.6	37.6	8.9	0.0	0.0	100.0

Table D-3: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Santa Teresa Monitoring Station for 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	1.5	1.2	0.2	0.0	0.0	0.0	3.0
NNE	1.3	0.9	0.0	0.0	0.0	0.0	2.2
NE	1.1	1.2	0.2	0.0	0.0	0.0	2.5
ENE	1.5	1.7	0.2	0.1	0.0	0.0	3.5
E	0.9	4.7	4.0	0.5	0.0	0.0	10.2
ESE	1.1	5.1	13.7	5.1	0.1	0.0	25.1
SE	0.9	2.4	2.1	0.0	0.0	0.0	5.4
SSE	0.7	1.2	0.4	0.0	0.0	0.0	2.2
S	0.7	2.0	0.5	0.0	0.0	0.0	3.2
SSW	1.2	1.7	0.2	0.1	0.0	0.0	3.2
SW	1.5	2.7	1.2	0.4	0.0	0.0	5.8
WSW	1.1	2.1	3.7	1.2	0.0	0.0	8.0
W	1.3	2.1	4.7	3.3	0.1	0.0	11.6
WNW	0.8	2.4	1.1	0.7	0.1	0.0	5.1
NW	1.3	2.6	1.1	0.1	0.0	0.0	5.1
NNW	1.4	1.7	0.6	0.1	0.0	0.1	3.9
Sub-Total	18.4	35.6	33.9	11.6	0.4	0.1	100.0

Table D-4: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Santa Teresa Monitoring Station for 2006

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.0	0.8	0.4	0.2	0.0	1.2
NNE	0.0	0.2	0.2	0.4	0.2	0.0	0.9
NE	0.4	0.2	0.4	0.6	0.4	0.4	2.1
ENE	0.4	0.2	1.0	1.8	1.0	0.4	4.1
E	1.4	0.2	3.6	8.5	1.8	1.4	14.7
ESE	1.2	2.4	6.9	11.4	2.6	3.6	24.5
SE	0.2	2.2	0.8	2.2	1.2	2.2	7.6
SSE	0.0	0.2	1.6	2.0	0.4	1.0	4.5
S	0.0	0.2	1.2	1.2	0.2	0.4	2.8
SSW	0.6	0.6	1.2	2.0	1.2	0.2	5.0
SW	0.4	0.0	1.0	0.4	0.2	0.0	1.7
WSW	0.0	0.6	3.2	1.2	0.2	0.0	4.5
W	0.0	0.0	2.8	2.4	1.4	0.6	6.2
WNW	0.0	0.0	0.6	2.4	1.0	0.8	4.1
NW	0.0	0.4	0.2	0.8	1.0	0.0	2.1
NNW	0.0	0.0	0.2	1.2	0.4	0.0	1.6
Sub-Total	4.0	6.4	22.2	33.8	11.6	9.5	87.4
Missing/Incomplete							12.6

Table D-5: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Santa Teresa Monitoring Station for 2012

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.0	0.4	0.2	0.2	0.0	0.7
NNE	0.0	0.2	1.0	1.4	0.8	0.4	3.4
NE	0.0	0.0	0.4	1.8	0.2	0.0	2.1
ENE	0.0	0.0	0.2	1.0	1.2	0.8	2.8
E	0.0	0.0	1.8	7.5	1.6	0.6	10.1
ESE	0.0	1.0	5.5	14.6	6.1	6.5	29.4
SE	0.0	0.0	1.6	7.3	2.4	1.4	11.2
SSE	0.0	0.4	0.4	3.9	0.4	0.8	5.1
S	0.0	0.2	0.6	3.5	0.2	0.8	4.6
SSW	0.0	0.2	1.2	1.4	0.2	0.0	2.7
SW	0.0	0.0	0.4	1.2	0.0	0.0	1.4
WSW	0.0	0.0	0.4	2.0	0.2	0.2	2.5
W	0.0	0.0	0.6	5.7	0.2	0.8	6.4
WNW	0.0	0.0	0.0	2.6	0.2	0.4	2.8
NW	0.0	0.0	0.0	0.8	0.0	0.0	0.7
NNW	0.0	0.0	0.6	0.6	0.2	0.0	1.2
Sub-Total	0.0	1.8	13.3	48.5	12.4	11.2	87.1
Missing/Incomplete							12.9

Table D-6: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Santa Teresa Monitoring Station for 2013

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.0	0.5	1.1	0.5	0.2	2.0
NNE	0.2	0.0	0.5	0.3	0.5	0.3	1.6
NE	0.0	0.2	0.0	0.6	0.2	0.2	1.0
ENE	0.2	0.0	0.2	1.0	0.6	0.6	2.3
E	0.8	0.6	0.8	3.7	2.2	1.9	9.0
ESE	0.3	1.3	5.6	9.9	3.5	2.7	20.9
SE	0.0	0.2	1.6	2.1	0.8	1.3	5.3
SSE	0.0	0.3	0.5	1.1	0.5	0.6	2.7
S	0.0	0.0	1.3	1.8	1.0	0.5	4.0
SSW	0.0	0.0	0.3	2.2	0.3	0.3	2.9
SW	0.0	0.0	0.6	4.6	0.8	0.0	5.4
WSW	0.0	0.0	1.1	5.6	1.4	1.0	8.2
W	0.0	0.0	1.4	11.0	1.9	0.2	13.0
WNW	0.0	0.0	0.3	3.8	1.0	0.0	4.6
NW	0.0	0.0	0.8	2.7	0.6	0.2	3.9
NNW	0.0	0.0	0.2	2.1	0.3	0.6	2.9
Sub-Total	1.3	2.3	14.0	48.1	14.4	9.4	89.6
Missing/Incomplete							10.4

Table D-7: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Desert View Monitoring Station for 2006

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	1.7	1.9	0.4	0.0	0.0	0.0	4.0
NNE	2.6	1.5	0.0	0.0	0.0	0.0	4.0
NE	0.6	0.2	0.0	0.2	0.0	0.0	1.0
ENE	0.6	2.1	0.0	0.0	0.0	0.0	2.7
E	1.7	3.8	1.9	0.4	0.0	0.0	7.7
ESE	4.1	11.5	6.2	2.4	0.0	0.0	23.5
SE	2.1	11.3	4.9	2.1	0.0	0.0	20.0
SSE	1.9	4.5	0.4	0.0	0.0	0.0	6.7
S	1.3	1.7	0.0	0.0	0.0	0.0	2.9
SSW	1.9	0.6	0.0	0.0	0.0	0.0	2.5
SW	2.4	1.9	0.0	0.0	0.0	0.0	4.2
WSW	1.9	2.4	3.2	0.2	0.0	0.0	7.5
W	0.4	1.5	1.5	1.3	0.0	0.0	4.6
WNW	0.4	1.7	0.4	0.0	0.0	0.0	2.5
NW	0.2	1.1	0.0	0.0	0.0	0.0	1.2
NNW	1.7	0.6	0.2	0.0	0.0	0.0	2.5
Sub-Total	24.9	47.2	18.7	6.4	0.0	0.0	97.3
Missing/Incomplete							2.7

Table D-8: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Desert View Monitoring Station for 2012

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	2.1	1.7	0.2	0.0	0.0	0.0	4.0
NNE	3.0	1.3	0.0	0.0	0.0	0.0	4.2
NE	3.4	0.4	0.4	0.0	0.0	0.0	4.2
ENE	2.1	2.8	0.4	0.0	0.0	0.0	5.2
E	2.6	7.3	5.1	0.0	0.0	0.0	14.6
ESE	3.0	18.6	13.0	0.4	0.0	0.0	34.1
SE	1.9	6.4	1.7	0.0	0.0	0.0	9.8
SSE	0.9	3.0	0.2	0.0	0.0	0.0	4.0
S	0.4	0.6	0.0	0.0	0.0	0.0	1.0
SSW	0.0	1.3	0.0	0.0	0.0	0.0	1.2
SW	0.4	1.1	0.0	0.0	0.0	0.0	1.5
WSW	1.1	1.1	1.5	0.0	0.0	0.0	3.5
W	0.4	1.7	3.4	0.0	0.0	0.0	5.4
WNW	0.4	0.4	0.0	0.0	0.0	0.0	0.8
NW	0.9	0.6	0.0	0.0	0.0	0.0	1.5
NNW	1.9	0.4	0.0	0.0	0.0	0.0	2.3
Sub-Total	23.9	47.4	25.4	0.4	0.0	0.0	97.1
Calms							0.2
Missing/Incomplete							2.7

Table D-9: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Desert View Monitoring Station for 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	4.2	2.1	0.0	0.0	0.0	0.0	6.0
NNE	5.6	2.1	0.0	0.0	0.0	0.0	7.3
NE	6.3	0.3	0.3	0.0	0.0	0.0	6.6
ENE	4.2	3.8	0.7	0.0	0.0	0.0	8.3
E	4.5	7.6	4.5	0.0	0.0	0.0	15.9
ESE	3.1	12.8	7.6	1.0	0.0	0.0	23.6
SE	3.1	5.2	1.4	0.0	0.0	0.0	9.3
SSE	0.7	0.7	0.3	0.0	0.0	0.0	1.7
S	1.0	0.7	0.0	0.0	0.0	0.0	1.7
SSW	0.3	0.7	0.0	0.0	0.0	0.0	1.0
SW	1.4	2.1	1.0	0.0	0.0	0.0	4.3
WSW	1.4	0.3	0.3	0.0	0.0	0.0	2.0
W	0.3	0.0	1.0	0.3	0.0	0.0	1.7
WNW	1.0	0.3	0.3	0.0	0.0	0.0	1.7
NW	1.0	0.0	0.0	0.0	0.0	0.0	1.0
NNW	3.1	0.7	0.0	0.0	0.0	0.0	3.7
Sub-Total	39.5	37.9	16.9	1.3	0.0	0.0	95.7
Calms							0.0
Missing/Incomplete							4.3

Table D-10: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Desert View Monitoring Station for 2006

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.2	0.2	0.6	1.3	1.1	0.6	3.6
NNE	0.0	0.2	0.6	2.1	0.0	1.1	3.6
NE	0.0	0.0	0.0	0.6	0.0	0.4	1.0
ENE	0.0	0.0	0.2	0.9	0.4	1.3	2.5
E	0.0	0.4	0.6	4.5	0.6	1.7	7.1
ESE	0.2	1.7	3.6	12.2	1.5	4.9	21.6
SE	0.2	0.9	2.6	7.9	3.6	5.4	18.4
SSE	0.0	0.4	0.2	1.7	1.1	3.4	6.1
S	0.0	0.0	0.2	1.3	0.4	1.1	2.7
SSW	0.0	0.2	1.1	0.4	0.2	0.4	2.1
SW	0.0	0.0	0.9	1.5	1.1	0.9	3.8
WSW	0.0	0.0	1.7	4.9	0.6	0.4	6.9
W	0.0	0.2	1.7	2.4	0.2	0.2	4.2
WNW	0.0	0.0	0.4	1.9	0.0	0.2	2.3
NW	0.0	0.2	0.0	1.1	0.0	0.0	1.1
NNW	0.0	0.0	0.9	1.3	0.2	0.2	2.3
Sub-Total	0.6	4.0	13.8	41.1	9.9	19.9	89.3
Missing/Incomplete							10.7

Table D-11: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Desert View Monitoring Station for 2012

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.2	1.3	1.7	0.9	0.0	3.0
NNE	0.0	0.4	0.9	2.8	0.4	0.0	4.0
NE	0.0	0.4	0.2	3.0	0.4	0.2	3.0
ENE	0.0	0.0	0.9	4.1	0.2	0.2	4.0
E	0.0	0.4	2.4	8.1	2.4	1.7	13.0
ESE	0.2	1.7	5.3	18.4	6.0	3.4	31.0
SE	0.2	0.4	1.5	3.2	2.1	2.6	8.0
SSE	0.0	0.0	0.6	1.3	1.1	1.1	3.0
S	0.0	0.2	0.0	0.6	0.2	0.0	0.0
SSW	0.0	0.0	0.4	0.9	0.0	0.0	1.0
SW	0.0	0.0	0.2	1.3	0.0	0.0	1.0
WSW	0.0	0.2	0.6	2.6	0.2	0.0	3.0
W	0.0	0.0	0.4	4.9	0.0	0.2	4.0
WNW	0.0	0.0	0.2	0.4	0.2	0.0	0.0
NW	0.0	0.0	0.0	1.1	0.2	0.2	1.0
NNW	0.0	0.2	1.3	0.9	0.0	0.0	2.0
Sub-Total	0.4	3.8	14.5	49.2	12.8	8.6	89.0
Missing/Incomplete							11

Table D-12: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Desert View Monitoring Station for 2013

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.3	0.7	2.4	1.4	1.4	5.2
NNE	0.0	0.3	1.0	4.5	1.0	0.7	6.4
NE	0.3	1.0	0.7	2.1	1.0	1.7	5.8
ENE	0.0	0.3	1.4	4.5	1.7	0.7	7.3
E	0.0	0.3	4.5	8.4	2.1	1.4	14.0
ESE	0.7	3.1	5.6	8.7	4.9	1.4	20.4
SE	0.3	0.3	1.7	4.2	1.7	1.4	8.2
SSE	0.0	0.0	0.3	1.4	0.0	0.0	1.5
S	0.0	0.0	0.7	0.7	0.3	0.0	1.5
SSW	0.3	0.0	0.0	0.7	0.0	0.0	0.9
SW	0.0	0.0	0.7	3.5	0.3	0.0	3.8
WSW	0.0	0.0	0.0	1.7	0.0	0.3	1.7
W	0.0	0.0	0.0	1.4	0.3	0.0	1.5
WNW	0.0	0.0	0.3	0.7	0.0	0.7	1.5
NW	0.0	0.0	0.0	1.0	0.0	0.0	0.9
NNW	0.0	0.3	0.7	1.7	0.3	0.7	3.2
Sub-Total	1.5	5.2	15.5	39.9	12.8	8.7	83.7
Missing/Incomplete							16.3

Table D-13: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Sunland Park Monitoring Station for 2006

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	1.0	1.0	0.0	0.0	0.0	0.0	2.0
NNE	2.0	0.0	0.0	0.0	0.0	0.0	2.0
NE	1.5	1.0	0.0	0.0	0.0	0.0	2.5
ENE	1.0	1.5	0.0	0.0	0.0	0.0	2.5
E	4.1	5.1	1.5	0.0	0.0	0.0	10.5
ESE	2.0	15.3	7.1	0.0	0.0	0.0	24.0
SE	2.6	8.2	5.6	0.0	0.0	0.0	16.0
SSE	0.0	2.6	1.0	0.0	0.0	0.0	3.5
S	2.0	2.0	0.0	0.0	0.0	0.0	4.0
SSW	1.0	1.5	0.0	0.0	0.0	0.0	2.5
SW	2.0	1.0	0.0	0.0	0.0	0.0	3.0
WSW	1.0	1.0	1.5	1.0	0.0	0.0	4.5
W	2.0	0.5	3.1	1.0	0.0	0.0	6.5
WNW	2.6	1.0	0.5	0.0	0.0	0.0	4.0
NW	3.6	2.0	0.5	0.0	0.0	0.0	6.0
NNW	2.6	2.0	0.0	0.0	0.0	0.0	4.5
Sub-Total	30.5	45.0	20.5	2.0	0.0	0.0	98.0
Missing/Incomplete							2.0

Table D-14: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Sunland Park Monitoring Station for 2012

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	2.0	0.8	0.2	0.0	0.0	0.0	3.0
NNE	1.2	0.8	0.0	0.0	0.0	0.0	2.0
NE	2.0	1.0	0.2	0.0	0.0	0.0	3.1
ENE	1.2	2.0	0.8	0.0	0.0	0.0	3.9
E	1.0	4.6	3.2	0.4	0.0	0.0	9.1
ESE	1.0	14.1	13.5	2.6	0.0	0.0	30.9
SE	1.4	7.3	1.4	0.0	0.0	0.0	10.0
SSE	1.6	3.4	0.0	0.0	0.0	0.0	4.9
S	1.8	1.6	0.0	0.0	0.0	0.0	3.3
SSW	0.6	1.2	0.0	0.0	0.0	0.0	1.8
SW	1.4	0.2	0.2	0.0	0.0	0.0	1.8
WSW	0.4	1.0	2.0	1.0	0.0	0.0	4.3
W	0.6	1.4	4.4	3.4	0.0	0.0	9.6
WNW	2.4	0.8	1.2	0.6	0.0	0.0	4.9
NW	2.2	1.2	0.2	0.0	0.0	0.0	3.5
NNW	2.2	0.8	0.0	0.0	0.0	0.0	3.0
Sub-Total	22.6	41.7	27.0	7.9	0.0	0.0	99.2
Missing/Incomplete							0.8

Table D-15: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at Sunland Park Monitoring Station for 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	7.9	0.0	0.0	0.0	0.0	0.0	7.5
NNE	1.6	0.0	0.0	0.0	0.0	0.0	1.5
NE	0.0	1.6	0.0	0.0	0.0	0.0	1.5
ENE	0.0	3.2	0.0	0.0	0.0	0.0	3.0
E	3.2	6.3	0.0	0.0	0.0	0.0	9.0
ESE	3.2	11.1	6.3	0.0	0.0	0.0	19.4
SE	3.2	4.8	1.6	0.0	0.0	0.0	9.0
SSE	1.6	0.0	0.0	0.0	0.0	0.0	1.5
S	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SSW	1.6	0.0	0.0	0.0	0.0	0.0	1.5
SW	1.6	0.0	0.0	0.0	0.0	0.0	1.5
WSW	3.2	3.2	0.0	0.0	0.0	0.0	6.0
W	7.9	1.6	0.0	0.0	0.0	0.0	9.0
WNW	4.8	3.2	0.0	0.0	0.0	0.0	7.5
NW	7.9	4.8	0.0	0.0	0.0	0.0	11.9
NNW	4.8	0.0	0.0	0.0	0.0	0.0	4.5
Sub-Total	49.3	37.3	7.5	0.0	0.0	0.0	94.0
Missing/Incomplete							6.0

Table D-16: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Sunland Park Monitoring Station for 2006

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.5	1.5	1.5	0.0	0.0	2.9
NNE	0.0	0.0	1.0	1.0	0.0	0.0	1.7
NE	0.5	0.0	0.0	0.0	1.0	1.0	2.1
ENE	0.0	0.5	0.0	1.5	0.5	0.0	2.1
E	0.0	0.0	2.5	3.0	2.0	3.0	8.8
ESE	0.5	1.5	6.9	9.9	4.5	0.5	20.2
SE	0.0	1.5	4.5	7.9	1.0	0.5	13.0
SSE	0.0	0.0	0.0	2.0	1.0	0.5	2.9
S	0.0	0.0	1.0	2.0	1.0	0.0	3.4
SSW	0.0	0.5	0.0	0.5	0.5	0.5	1.7
SW	0.0	0.0	0.5	0.0	0.5	2.0	2.5
WSW	0.0	0.0	0.5	2.5	0.5	1.0	3.8
W	0.0	0.0	0.0	5.9	0.0	0.5	5.5
WNW	0.0	0.0	2.0	1.5	0.0	1.0	3.8
NW	0.0	0.0	2.0	3.0	0.5	1.5	5.9
NNW	0.0	0.0	1.5	3.0	0.5	0.5	4.6
Sub-Total	0.8	3.8	20.2	38.2	11.3	10.5	84.9
Missing/Incomplete							15.1

Table D-17: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Sunland Park Monitoring Station for 2012

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.0	0.4	2.0	0.4	0.2	2.8
NNE	0.0	0.2	0.6	0.8	0.2	0.2	1.9
NE	0.0	0.0	1.0	1.6	0.2	0.4	3.0
ENE	0.0	0.0	0.4	2.8	0.6	0.2	3.7
E	0.0	0.4	1.0	5.0	1.6	1.2	8.6
ESE	0.0	1.6	4.8	16.6	5.2	3.0	29.1
SE	0.0	0.2	0.6	3.6	2.4	3.0	9.1
SSE	0.2	0.2	0.6	1.4	1.2	1.4	4.7
S	0.2	0.2	0.8	1.0	0.4	0.8	3.2
SSW	0.0	0.0	0.2	1.0	0.4	0.2	1.7
SW	0.0	0.2	0.4	1.0	0.2	0.0	1.7
WSW	0.0	0.2	0.8	3.4	0.0	0.0	4.1
W	0.0	0.0	1.6	7.4	0.6	0.2	9.1
WNW	0.0	0.0	0.8	2.8	1.2	0.2	4.7
NW	0.0	0.4	0.8	2.4	0.0	0.0	3.4
NNW	0.0	0.4	0.8	1.2	0.4	0.2	2.8
Sub-Total	0.4	3.7	14.5	50.3	14.0	10.4	93.3
Missing/Incomplete							6.7

Table D-18: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at Sunland Park Monitoring Station for 2013

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.0	1.6	4.8	1.6	0.0	5.1
NNE	0.0	0.0	0.0	1.6	0.0	0.0	1.0
NE	0.0	0.0	0.0	1.6	0.0	0.0	1.0
ENE	0.0	0.0	0.0	1.6	0.0	1.6	2.0
E	0.0	0.0	1.6	6.3	1.6	0.0	6.1
ESE	0.0	4.8	7.9	4.8	1.6	1.6	13.1
SE	0.0	0.0	1.6	7.9	0.0	0.0	6.1
SSE	0.0	1.6	0.0	0.0	0.0	0.0	1.0
S	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SSW	0.0	0.0	0.0	1.6	0.0	0.0	1.0
SW	0.0	0.0	1.6	0.0	0.0	0.0	1.0
WSW	0.0	0.0	3.2	3.2	0.0	0.0	4.0
W	0.0	3.2	3.2	3.2	0.0	0.0	6.1
WNW	0.0	0.0	3.2	3.2	1.6	0.0	5.1
NW	0.0	0.0	0.0	9.5	3.2	0.0	8.1
NNW	1.6	1.6	1.6	0.0	0.0	0.0	3.0
Sub-Total	1.0	7.1	16.2	31.3	6.1	2.0	63.6
Missing/Incomplete							36.4

Table D-19: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at UTEP Monitoring Station for 2006

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	0.4	0.0	0.0	0.0	0.0	0.0	0.4
NNE	0.6	0.0	0.0	0.0	0.0	0.0	0.6
NE	0.6	0.2	0.0	0.2	0.0	0.0	1.1
ENE	1.3	1.3	0.9	0.0	0.0	0.0	3.4
E	2.8	3.2	0.2	0.0	0.0	0.0	6.2
ESE	6.2	11.1	4.3	0.4	0.0	0.0	22.0
SE	6.0	8.1	4.7	0.4	0.0	0.0	19.2
SSE	4.1	1.9	0.4	0.0	0.0	0.0	6.4
S	3.0	0.9	0.0	0.0	0.0	0.0	3.8
SSW	3.0	0.4	0.0	0.0	0.0	0.0	3.4
SW	1.1	1.5	0.2	0.0	0.0	0.0	2.8
WSW	3.0	1.5	0.6	0.0	0.0	0.0	5.1
W	3.6	3.0	1.9	1.1	0.0	0.0	9.6
WNW	2.6	2.4	0.2	0.4	0.0	0.0	5.5
NW	2.1	4.3	1.1	0.0	0.0	0.0	7.5
NNW	0.6	0.6	0.0	0.0	0.0	0.0	1.3
Sub-Total	40.9	40.3	14.5	2.6	0.0	0.0	98.3
Calms							1.3
Missing/Incomplete							0.42644

Table D-20: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at UTEP Monitoring Station for 2012

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NNE	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE	1.0	1.3	0.0	0.0	0.0	0.0	2.3
ENE	1.9	1.7	1.7	0.0	0.0	0.0	5.2
E	3.6	4.4	2.7	0.0	0.0	0.0	10.6
ESE	7.1	16.8	6.9	0.2	0.0	0.0	30.9
SE	5.5	12.6	1.5	0.0	0.0	0.0	19.4
SSE	4.8	3.1	0.0	0.0	0.0	0.0	7.9
S	1.7	1.0	0.0	0.0	0.0	0.0	2.7
SSW	1.7	0.0	0.0	0.0	0.0	0.0	1.7
SW	1.9	0.2	0.0	0.0	0.0	0.0	2.1
WSW	1.3	0.2	0.2	0.0	0.0	0.0	1.7
W	3.6	0.8	1.5	0.0	0.0	0.0	5.8
WNW	1.3	2.1	0.6	0.2	0.0	0.0	4.2
NW	1.0	0.6	0.6	0.0	0.0	0.0	2.3
NNW	0.0	0.0	0.2	0.0	0.0	0.0	0.2
Sub-Total	36.1	44.7	15.9	0.4	0.0	0.0	97.1
Calms							2.5
Missing/Incomplete							0.4

Table D-21: Percentage of Frequency Distribution of Wind Direction and Wind Speed (m/s) at UTEP Monitoring Station for 2013

Directions / Wind Classes (m/s)	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	TOTAL
N	1.6	0.3	0.3	0.0	0.0	0.0	2.2
NNE	1.6	0.0	0.3	0.0	0.0	0.0	1.9
NE	1.1	0.5	0.3	0.0	0.0	0.0	1.9
ENE	2.4	2.4	0.5	0.0	0.0	0.0	5.4
E	4.1	4.9	0.8	0.0	0.0	0.0	9.7
ESE	6.5	10.6	4.3	0.0	0.0	0.0	21.3
SE	7.0	9.8	0.5	0.0	0.0	0.0	17.3
SSE	2.7	1.6	0.0	0.0	0.0	0.0	4.3
S	1.9	1.4	0.0	0.0	0.0	0.0	3.2
SSW	1.4	0.3	0.0	0.0	0.0	0.0	1.6
SW	1.4	0.8	0.0	0.0	0.0	0.0	2.2
WSW	2.2	1.1	0.3	0.0	0.0	0.0	3.5
W	3.0	1.4	3.5	0.0	0.0	0.0	7.8
WNW	1.9	3.5	1.6	0.0	0.0	0.0	7.0
NW	1.1	2.4	0.8	0.0	0.0	0.0	4.3
NNW	1.1	0.5	0.0	0.0	0.0	0.0	1.6
Sub-Total	40.7	41.2	13.2	0.0	0.0	0.0	95.1
Calms							4.3
Missing/Incomplete							0.5

Table D-22: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at UTEP Monitoring Station for 2006

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.0	0.0	0.2	0.0	0.2	0.4
NNE	0.0	0.0	0.0	0.4	0.0	0.2	0.6
NE	0.0	0.0	0.0	0.9	0.0	0.2	0.9
ENE	0.0	0.0	1.3	1.1	0.6	0.4	3.0
E	0.0	0.4	1.1	1.7	0.4	2.6	5.4
ESE	0.0	2.4	3.4	8.4	3.0	4.9	19.3
SE	0.0	0.9	1.9	9.4	1.3	5.8	16.8
SSE	0.0	0.0	0.2	1.9	1.1	3.6	6.0
S	0.0	0.2	0.2	0.4	0.9	2.1	3.4
SSW	0.0	0.0	0.2	0.6	0.0	2.6	3.0
SW	0.0	0.0	1.3	1.5	0.4	0.2	3.0
WSW	0.0	0.2	1.1	3.0	0.0	0.9	4.5
W	0.0	0.9	3.4	4.1	0.4	1.1	8.6
WNW	0.2	0.2	1.3	2.8	0.4	0.6	4.9
NW	0.6	1.1	1.1	3.2	0.9	0.6	6.5
NNW	0.0	0.0	0.0	0.6	0.2	0.4	1.1
Sub-Total	0.7	5.4	14.4	35.1	8.4	23.2	87.3
Missing/Incomplete							12.7

Table D-23: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at UTEP Monitoring Station for 2012

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.0	0.2	0.0	0.0	0.0	0.2
NNE	0.0	0.0	0.0	0.0	0.0	0.2	0.2
NE	0.0	0.2	0.0	0.8	1.3	0.2	2.2
ENE	0.0	0.0	2.1	2.5	0.6	0.0	4.6
E	0.2	1.5	2.1	5.3	0.6	1.5	9.8
ESE	0.0	1.7	4.6	17.1	3.8	4.2	27.4
SE	0.2	0.6	2.1	9.3	4.2	3.4	17.3
SSE	0.0	0.0	1.3	3.4	1.7	1.7	7.0
S	0.0	0.0	0.4	1.1	0.6	0.6	2.4
SSW	0.0	0.0	0.8	0.6	0.4	0.2	1.8
SW	0.2	0.0	0.4	0.6	0.6	0.2	1.8
WSW	0.2	0.0	0.4	0.6	0.4	0.2	1.7
W	0.0	0.2	1.9	2.9	0.4	0.2	5.0
WNW	0.0	0.4	1.1	1.9	0.6	0.4	3.9
NW	0.0	0.4	0.8	1.1	0.0	0.0	2.0
NNW	0.0	0.2	0.0	0.0	0.0	0.0	0.2
Sub-Total	0.7	4.6	16.0	41.3	13.4	11.4	87.5
Missing/Incomplete							12.5

Table D-24: Percentage of Frequency Distribution of Wind Direction and Ozone Concentration (ppb) at UTEP Monitoring Station for 2013

Directions / O_3 Concentration(ppb)	0 - 40	40 - 50	50- 60	60 - 70	70 - 75	>= 75	TOTAL
N	0.0	0.3	0.8	1.4	0.0	0.3	2.3
NNE	0.0	0.3	0.5	0.5	0.0	0.5	1.6
NE	0.0	0.0	0.3	1.4	0.3	0.3	1.8
ENE	0.0	0.0	0.8	2.7	1.4	0.8	4.8
E	0.8	1.4	2.2	4.3	0.3	0.8	8.2
ESE	0.5	2.2	6.8	7.6	2.7	1.6	18.1
SE	0.3	0.5	2.2	10.6	2.7	1.4	14.9
SSE	0.0	0.3	0.5	2.4	0.5	0.8	3.9
S	0.0	0.0	0.3	1.9	0.0	1.4	3.0
SSW	0.0	0.0	0.5	0.5	0.5	0.0	1.4
SW	0.3	0.5	0.5	0.5	0.3	0.3	2.1
WSW	0.0	0.3	0.5	3.0	0.3	0.3	3.7
W	0.0	0.0	2.2	4.3	0.5	1.1	6.9
WNW	0.3	0.5	2.4	3.3	0.8	0.5	6.6
NW	0.3	0.8	1.6	1.4	0.0	0.5	3.9
NNW	0.0	0.0	0.0	0.8	0.3	0.5	1.4
Sub-Total	2.1	5.9	18.8	39.4	8.9	9.4	84.4
Missing/Incomplete							15.6

Appendix E: HYSPLIT Individual Trajectories for Clusters in 2006 (72-hour), Individual Trajectories not Clustered and Total Spatial Variance Graph

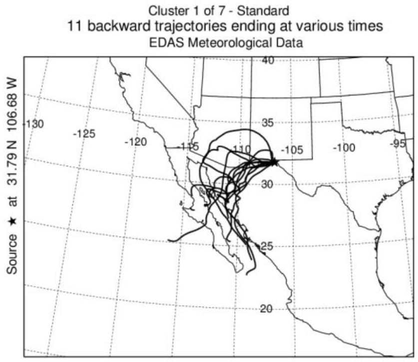


Figure E-1: Cluster 1 of 7

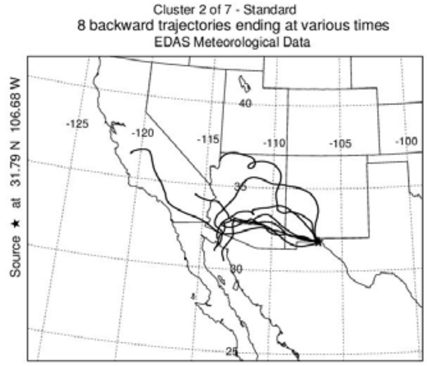


Figure E-2: Cluster 2 of 7

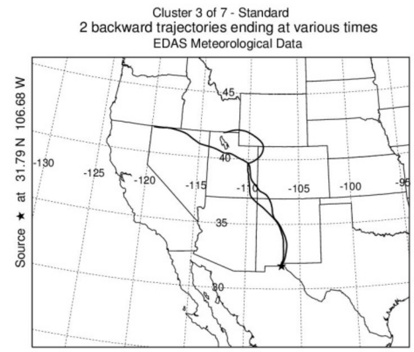


Figure E-3: Cluster 3 of 7

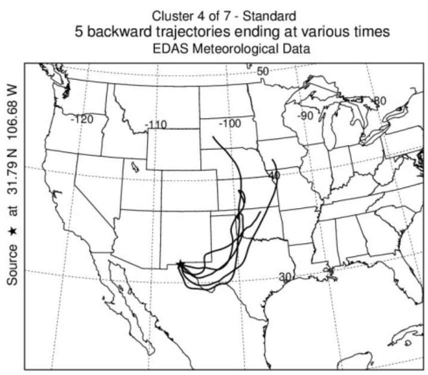


Figure E-4: Cluster 4 of 7

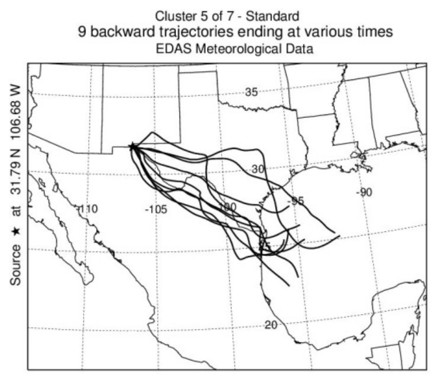


Figure E-5: Cluster 5 of 7

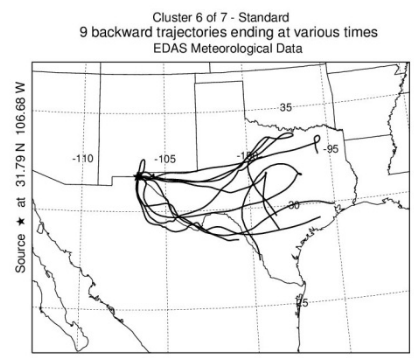


Figure E-6: Cluster 6 of 7

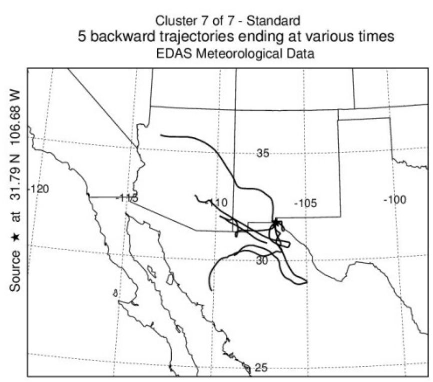


Figure E-7: Cluster 7 of 7

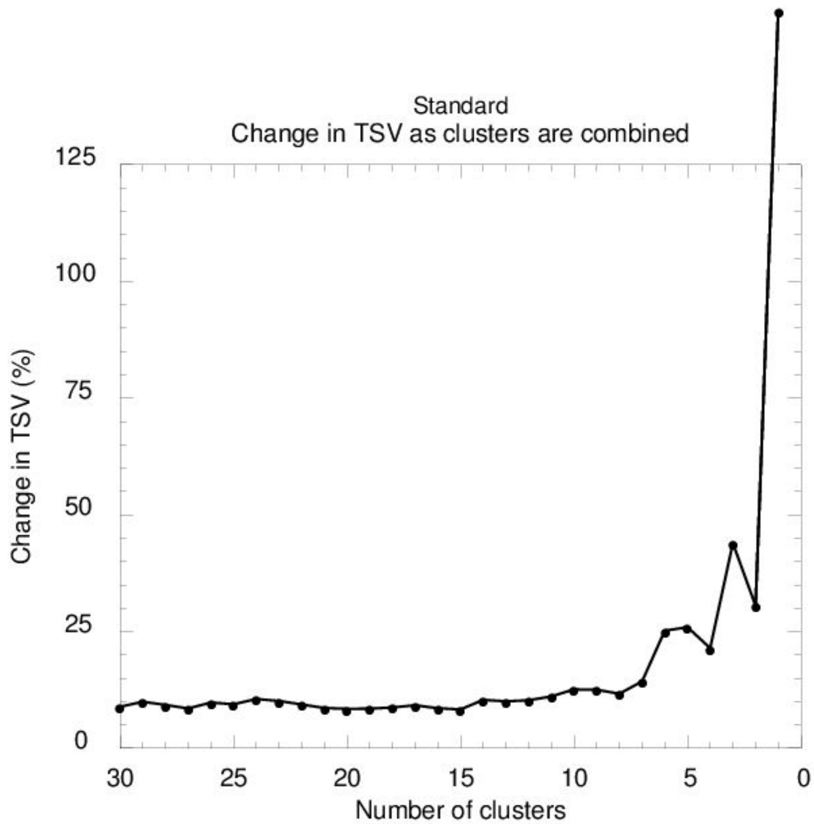


Figure E-8: Total Spatial Variance for 72-hr Trajectory Cluster Analysis for 2006

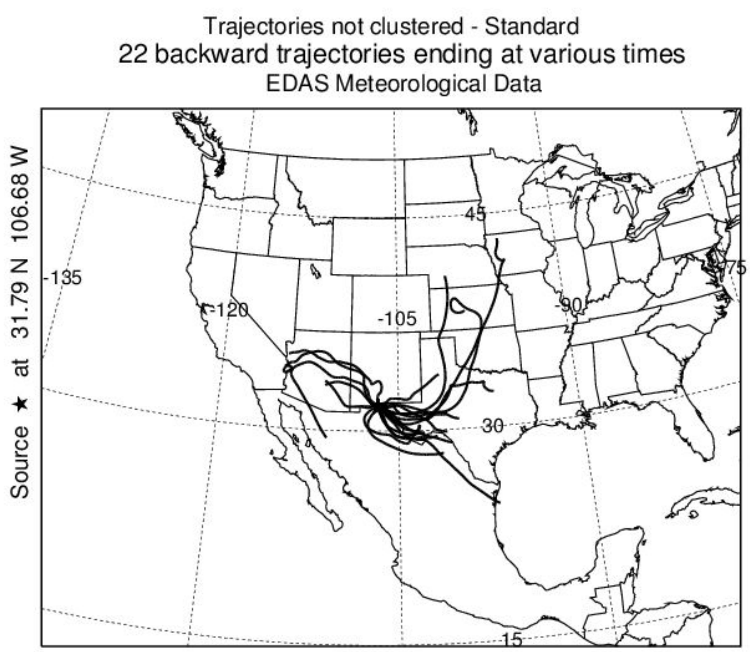


Figure E-9: 22 of 71 Trajectories not clustered for 72-hr Trajectory Cluster Analysis for 2006

Appendix F: HYSPLIT Individual Trajectories for Clusters in 2012 (72-hour), Individual Trajectories not Clustered and Total Spatial Variance Graph

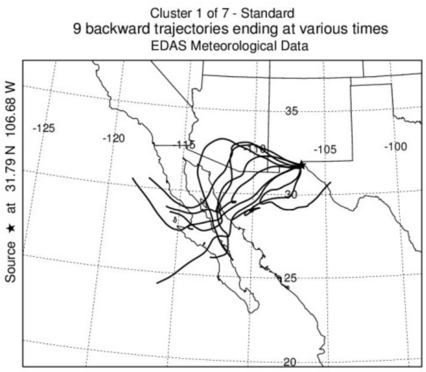


Figure F-1: Cluster 1 of 7

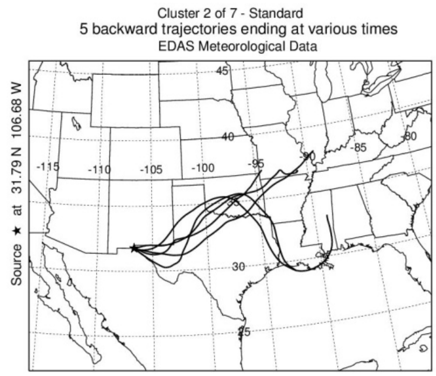


Figure F-2: Cluster 2 of 7

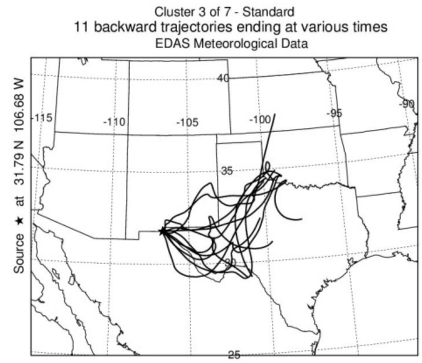


Figure F-3: Cluster 3 of 7

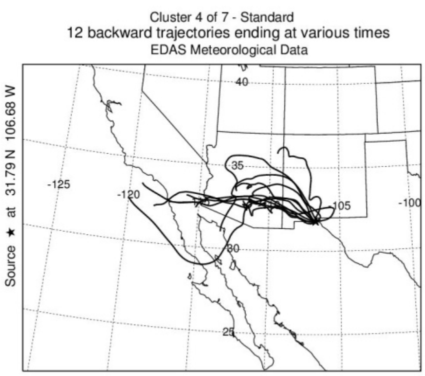


Figure F-4: Cluster 4 of 7

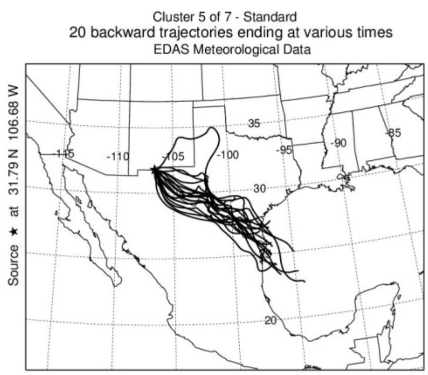


Figure F-5: Cluster 5 of 7

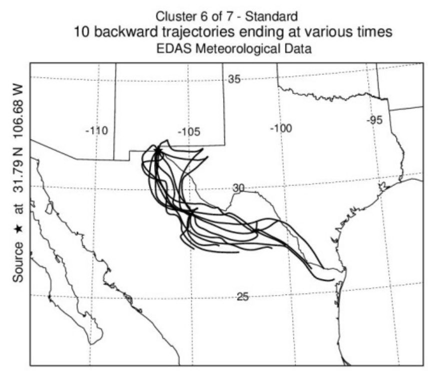


Figure F-6: Cluster 6 of 7

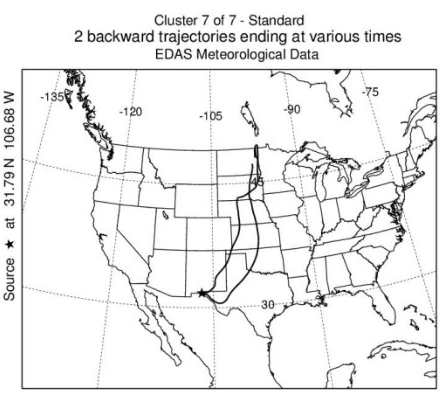


Figure F-7: Cluster 7 of 7

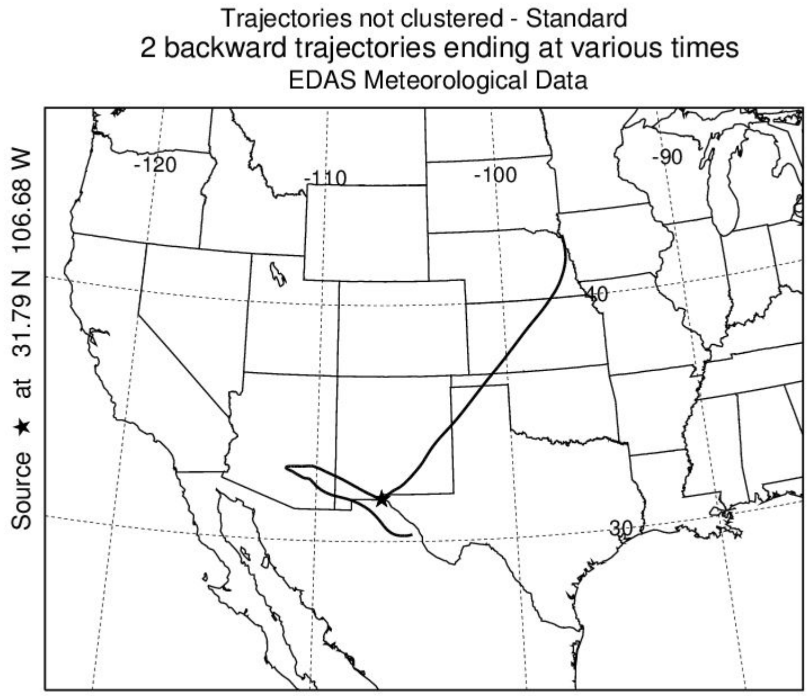


Figure F-8: 2 of 71 Trajectories not Clustered for 72-hr Trajectory Cluster Analysis for 2012

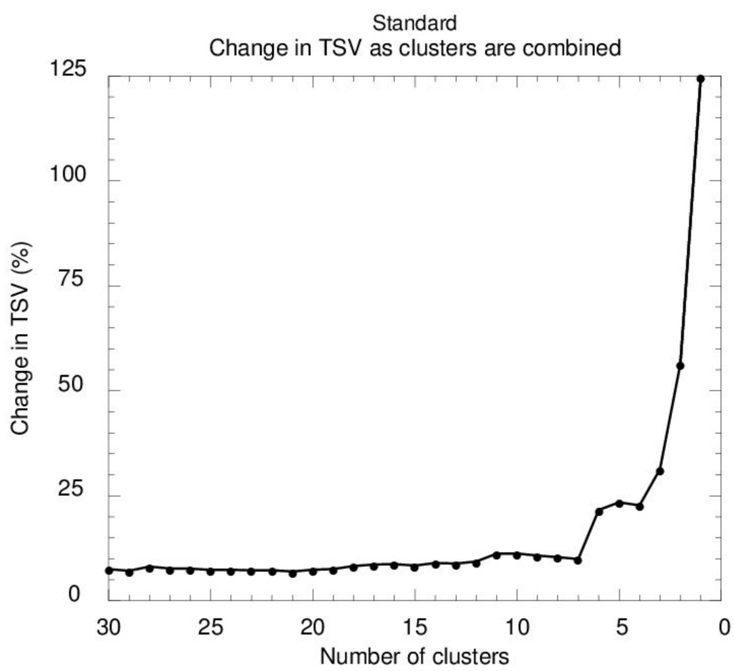


Figure F-9: Total Spatial Variance for 72-hr Trajectory Cluster Analysis for 2012

Appendix G: HYSPLIT Individual Trajectories for Clusters in 2013 (72-hour), Individual Trajectories not Clustered and Total Spatial Variance Graph

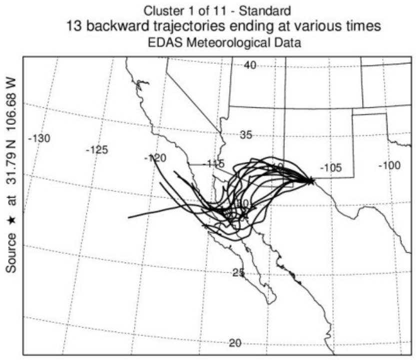


Figure G-1: Cluster 1 of 11

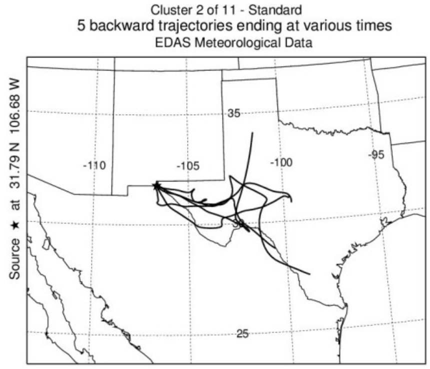


Figure G-2: Cluster 2 of 11

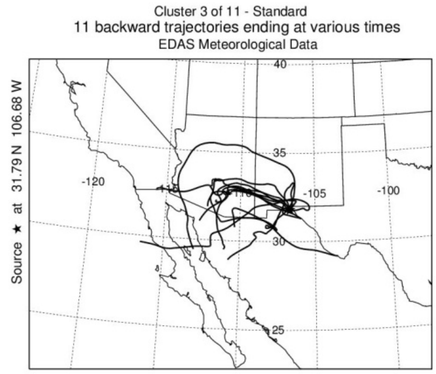


Figure G-3: Cluster 3 of 11

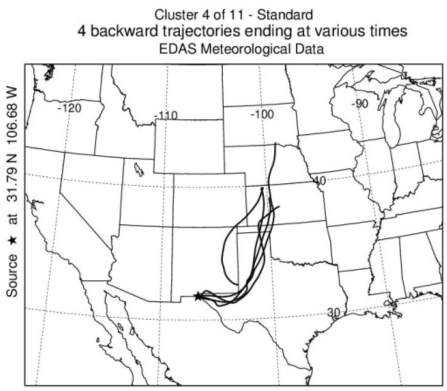


Figure G-4: Cluster 4 of 11

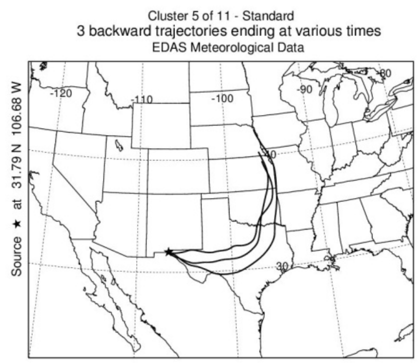


Figure G-5: Cluster 5 of 11

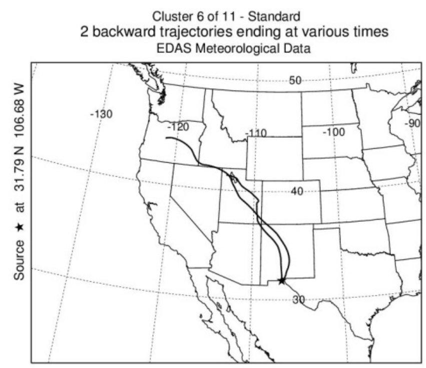


Figure G-6: Cluster 6 of 11

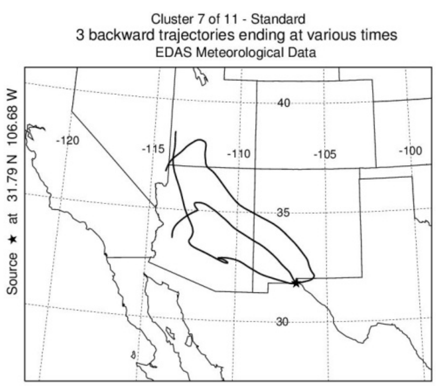


Figure G-7: Cluster 7 of 11

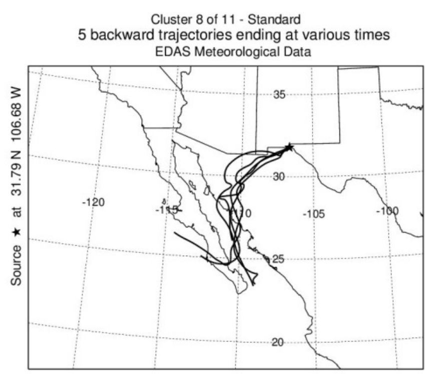


Figure G-8: Cluster 8 of 11

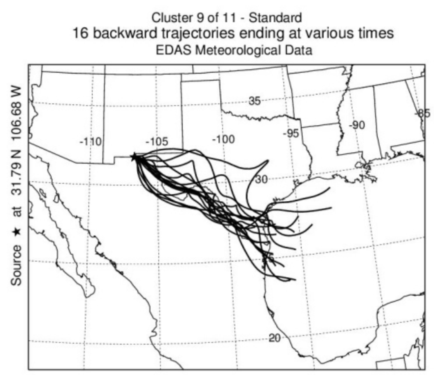


Figure G-9: Cluster 9 of 11

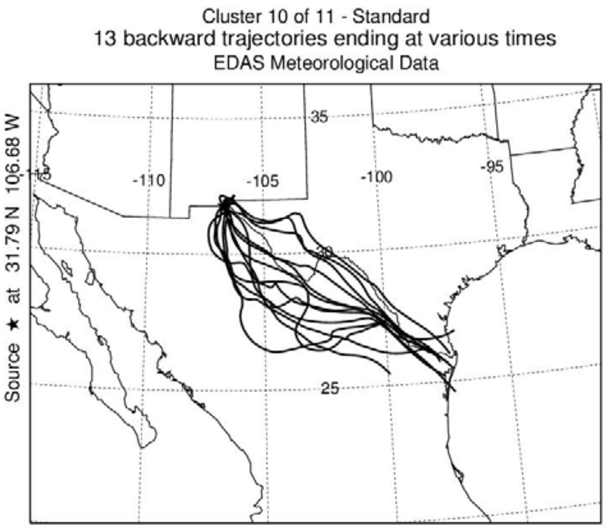


Figure G-10: Cluster 10 of 11

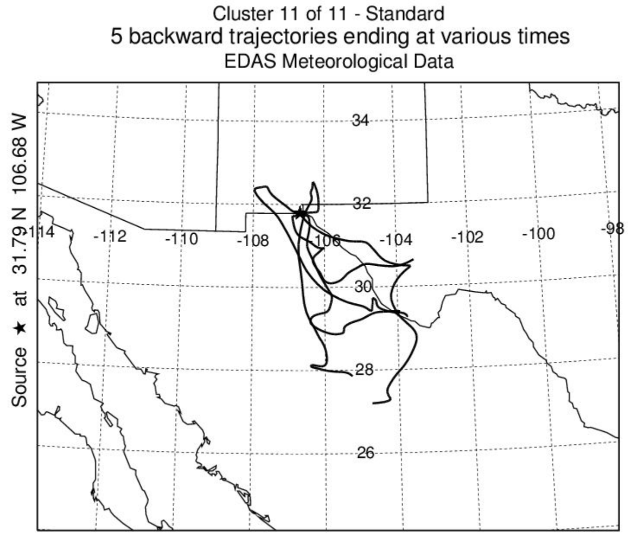


Figure G-11: Cluster 11 of 11

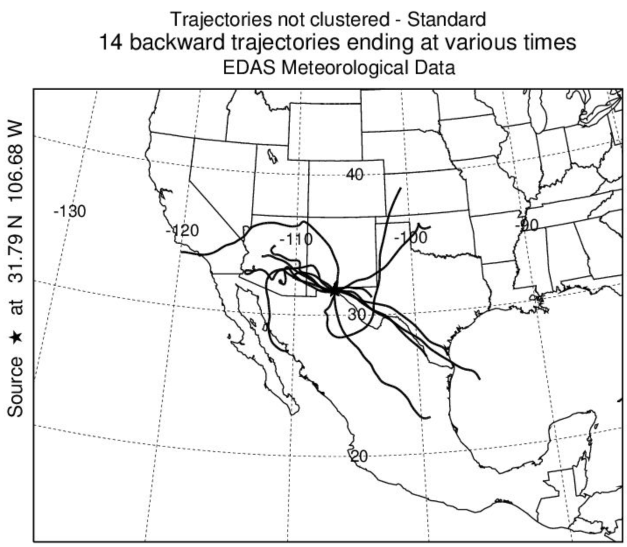


Figure G-12: 14 of 94 Trajectories not Clustered for 72-hr Trajectory Cluster Analysis for 2013

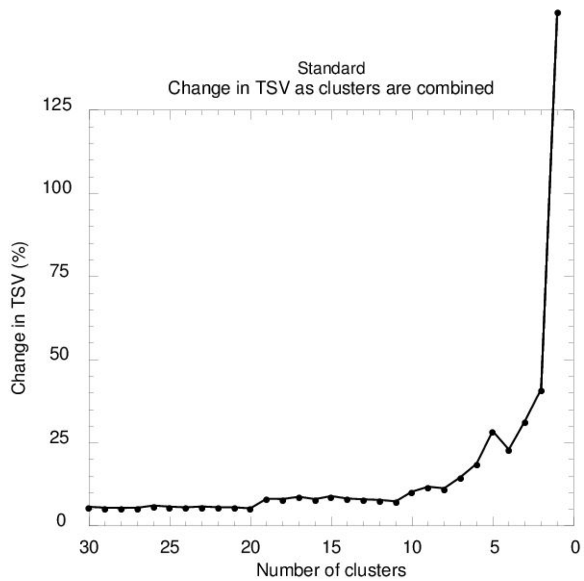


Figure G-13: Total Spatial Variance for 72-hr Trajectory Cluster Analysis for 2013

Vita

Maria Aurelia Sisneros was born in El Paso, Texas on June 16, 1977. She graduated as valedictorian from Jefferson High School in May 1995. Ms. Sisneros attended the Massachusetts Institute of Technology (MIT) from 1995-2000, where she earned her Bachelor's Degree in Environmental Engineering and Science in May 2000. During her studies she had the opportunity to intern in EPA's Laboratories in Lexington, Massachusetts conducting analysis on soil and water samples from EPA Superfund sites. After receiving her bachelor's degree she lived abroad in Madrid Spain for a year, serving as a volunteer with her church. After returning to the United States, Ms. Sisneros worked for Raba-Kistner (R.K.) Consultants in El Paso, Texas as an environmental consultant for approximately two and half years. During her time with R.K. Consultants she performed Environmental Phase II and II assessments, asbestos and mold surveys, prepared facility documents for state and federal compliance under various regulations.

In 2003 she moved to Atlanta, Georgia to work with the U.S. Environmental Protection Agency Region 4 Air Quality Division. During her time in Atlanta, Ms. Sisneros worked with the Emergency Planning and Community Right to Know Act (EPCRA), Indoor Air Quality and Air Permitting sections. She also worked with the American Indian and Environmental Office (AIEO) in Washington, D.C. where she assisted with a number of tribal projects located in North Carolina. In 2004, she began to work for EPA Region's 6 El Paso Border office, where she currently holds her position as Environmental Engineer and Public Liaison. Ms. Sisneros serves as a technical advisor within the office on border related issues relating to emergency preparedness and response, education and water. During her time at EPA she has worked as a technical writer on several Good Neighbor Environmental Board reports; documents submitted to the US President which give a current state of border issues and recommendations to the Administration.

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This thesis was typed by Maria Aurelia Sisneros.