Abstract

The focus of the current proposal is identification of dust events in El Paso using three complementary methods for 2000-2020. This will enable a multi-faceted analysis of long-term trends and a comparison of the strengths and weaknesses across these methods, which address Texas AQRP Research Priority: long term trends in dust sources in West Texas. We will apply several different methods for identification and characterization of dust events: (1) remote sensing from satellite observations (Lambert, Hallar et al. 2020) and surface-based column measurements (Hallar, Petersen et al. 2015), (2) extraction of dust event descriptions from National Weather Service (NWS) reports (Kelley and Ardon-Dryer 2021), and (3) assessment of dust contributions to particulate matter (PM) from in-situ aerosol observations (e.g. TCEQ PM_{10}, $PM_{2.5}$ and PM speciation data; (Sheesley and Usenko 2024, Rodriguez Ortiz, Mehra et al. 2025)). Each method utilizes a different dataset and, when combined, this project will offer a well-rounded characterization of dust events. We plan to compare results of dust event identification across these three methods for 2000-2020 in El Paso, TX to better understand how the input data informs dust event identification and characterization.

Quality Assurance Project Plan (QAPP)

Project 26-001
Longterm trends in dust sources in West Texas

Prepared for
Texas Air Quality Research Program (AQRP)
The University of Texas at Austin

Prepared by

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Version 2

Baylor University has prepared this QAPP following the Environmental Protection Agency (EPA) guidelines for Quality Assurance (QA) Category III Project: Secondary Data. It is submitted to the Texas Air Quality Research Program (AQRP) as required in the Work Plan requirements.

QA Requirements: Technical Systems Audits - Not Required for the Project
Audits of Data Quality – 10% Required

Table of Contents

Approvals Sheet

This document is a Category III Quality Assurance Project Plan for *the Long-term trends in dust sources in West Texas* project. The Principal Investigators for the project are Rebecca Sheesley, Gannet Hallar, Elisabeth Andrews, and Erin Boedicker.

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1. Project Description and Objectives

1.1 Environmental Systems to be Evaluated

The focus of the current proposal is identification of dust events which impact air quality in El Paso, TX using three complementary methods for 2000-2025. We will be evaluating dust data from remote sensing, weather report archives and surface-based aerosol and PM observations.

1.2 Purpose and Objectives

We will apply several different methods for identification and characterization of dust events: (1) remote sensing from satellite observations (Lambert, Hallar et al. 2020) and surface-based column measurements (Hallar, Petersen et al. 2015), (2) extraction of dust event descriptions from National Weather Service (NWS) reports (Kelley and Ardon-Dryer 2021), and (3) assessment of dust contributions to particulate matter (PM) from in-situ aerosol observations (e.g. TCEQ particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 micron diameter ($PM_{2.5}$) and PM speciation data; (Sheesley and Usenko 2024, Rodriguez Ortiz, Mehra et al. 2025)). Each method utilizes a different dataset and, when combined, this project will offer a well-rounded characterization of dust events. We plan to compare results of dust event identification across these three methods for 2000-2025 in El Paso, TX to better understand how the input data informs dust event identification and characterization.

Remote sensing (satellite and ground-based) can be used to identify dust events (e.g., (Chu, Kaufman et al. 2002)). Here we will use two remote sensing techniques. First, we will identify dust events using Moderate Resolution Imaging Spectrometer (MODIS) satellite data as was done in Lambert et al. (2020). Second, we will use ground-based column properties derived from the United State Department of Agriculture (USDA) UV-B network as was done in Hallar et al. (2015).

Our second method will use information from NWS report archives as in Kelley and Ardon-Dryer (2021), which was completed for Lubbock, TX. This method aligns dust event identification with meteorological characterization and is useful for estimating duration of events as well. As this method has already been applied in West Texas, there would be opportunity for comparison between El Paso and Lubbock or West Texas dust event identification (Kelley and Ardon-Dryer 2021, Guzman-Gonzalez, Fitzgerald et al. 2024).

Finally, we will utilize the significant archive of in-situ PM monitoring data available for El Paso. There is real time observation data using a tapered element oscillating microbalance (TEOM) for PM_{10} and $PM_{2.5}$, which is critical for understanding dust influence of short events (Ardon-Dryer 2025, Rodriguez Ortiz, Mehra et al. 2025). Additionally, there is 24-hr $PM_{2.5}$ mass and speciation data, including crustal elements, which are important in determining potential dust sources (Hand, White et al. 2016). Finally, in 2019 and 2020, there is aerosol optical property data from the BC2 network operated by PI Sheesley with support from AQRP and TCEQ, respectively. These combined aerosol datasets will allow for identification and characterization of dust events in El Paso for 2000-2025, analysis of trends in $PM_{2.5}$ that can be compared to previous efforts focused on Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites (Hand, White et al. 2016) and a better understanding of the impact of large dust events on local $PM_{2.5}$.

Tasks:

1) Conduct dust event identification using three different methods for 2000-2025 in El Paso (remote sensing, NWS, and in-situ aerosol)
   a) *Remote sensing*; Using the methodology developed within Dr. Hallar's research group (Lambert, Hallar et al. 2020), MODIS aerosol optical depth (AOD) observations will be obtained from the Collection 6.1 MOD08 (Terra) Level 3 global atmosphere product containing gridded 1° by 1° daily averages of spectral AOD (Levy, Mattoo et al. 2013). Temporal resolution is roughly 2 days. An extinction Ångström exponent (EAE) constraint will be used to segregate dust events from other high AOD events (e.g., due to wildfires). EAE is inversely related to particle size. Lambert et al (2020) used AE<0.75 in their study, but EAE thresholds of 0.9, 0.5, and 0.3 have also been shown to separate dust from other aerosol types depending on site specifics (Moulin, Dulac et al. 1997, Moulin, Guillard et al. 1997, Eck, Holben et al. 1999, Pinker, Pandithurai et al. 2001, Gautam, Liu et al. 2009). Additionally, we will leverage ground based remote sensing instrumentation available in Texas. Specifically, the US Department of Agriculture's UV-B Monitoring and Research Program (UVMRP) has sites in El Paso, Houston, Panther Junction, and Seguin Texas, and two decades of data is available for each of these sites. This network includes visible Multifilter Rotating Shadowband Radiometers (vis-MFRSR) [Bigelow et al., 1998]. A high-quality time series of vis-MFRSR cloud-screened and calibrated AOD is created at numerous wavelengths, and thus an EAE, can be calculated. As with the satellite analysis, dust events are clearly distinguished using an EAE constraint [Hallar et al., 2015]. Dr. Haller's paper (Lambert et al, 2020) will be used as a reference for starting points of EAE, however, that analysis was based on agricultural dust. We will likely modify the EAE constraint values based on cases of known events that in El Paso during our time period (2000-2025) as we may expect more mineral dust in this region. We will make recommendations for future use for thresholds that are valuable for understanding PM in this region.
   b) *National Weather Service*: We will follow a methodology previously used to identify dust events based on National Weather Service (NWS) data archives (e.g., (Hahnenberger and Nicoll 2012, Kelley and Ardon-Dryer 2021)). Specifically, we will download Meteorological Aerodrome Reports (METARs) for the time period (2000-2025) which are freely available from the Iowa Environmental Mesonet website [Iowa Environmental Mesonet, 2020]. METAR observations are primarily based at airports as the information is critical for aviation safety. These files include standard meteorological information (e.g., temperature, relative humidity, pressure, wind speed, wind direction, visibility) from the NWS Automated Surface Observation System (ASOS). The files also include present weather codes, some of which are automated (rain, mist, fog) and some of which (e.g., thunderstorm, dust, etc.) are inserted by an official weather observer. We will use the ASOS and

METAR data for a 100-mile radius around El Paso (a zoomable map for US sites is provided by the NWS: https://www.weather.gov/asos). This 100-mile radius includes the observations in El Paso as well as additional stations in Texas, New Mexico, and Mexico. METAR data is available in 5min time resolution (sometimes 1 min), which will also allow assessment of the duration of identified dust events. The ASOS/METAR observations do not directly indicate PM loading, but visibility is an indicator of dust event intensity, with lower visibility indicating a bigger dust event. PM loading can be estimated from visibility (e.g., (Li, Kang et al. 2022)).

c) *In-situ aerosol*: The real time TEOM data provides an opportunity to detect dust events on any day but has the potential to be less specific. During the TCEQ BC2 projects, we identified dust events based on enhancements above the average scattering coefficient and scattering Ångström exponent (SAE) less than 0.5 (Sheesley, Usenko et al. 2024); we will use the 2019-2021 in-situ aerosol optical data to develop an identification algorithm to target large-scale events using the 2000-2025 TEOM data in El Paso. We will identify dust events based on changes in PM10 concentration, PM10:PM2.5 ratios, and threshold values for PM. Threshold values for PM concentration and duration of elevated PM will be applied to minimize false positives and to more effectively target large-scale events. PM speciation will be used as available to confirm dust event identification. Thresholds for PM enhancement and duration of event will take into account local characteristics and be cross-referenced with the other dust identification methods. Since we have 2019, 2020 and 2021 aerosol optical data, we will use those years to develop a threshold algorithm for the long-term data (e.g. PM10, wind, PM2.5) to enable automated identification of dust events for years with only PM2.5 and PM10.

2) Trend analysis
   a) Number, duration, and PM concentration trend analysis for El Paso for events identified by different methods in Task 1.
   b) Here, we will estimate trends in dust events based on several event characteristics: (i) number of events/year, (ii) mean (and median) duration of events/year and (iii) mean (and median) intensity of events/year. The proxy for intensity will depend on the specific dataset: for example – METAR data dust intensity would be described by visibility, air quality data dust intensity would be described by PM loading, and remote sensing data dust intensity by AOD. Annual trends require a time series of at least 10 years (e.g., (Weatherhead, Reinsel et al. 1998)), so we will be able to assess trends for all datasets except the BC2 campaign optical data. To assess trends in duration, we will need both a long enough time series and high-resolution data so that duration of each event can be determined. The significance of each trend will be evaluated by looking at correlation coefficients as well as other standard statistical tests (e.g., parametric *t* test assuming one degree of freedom per year).

3) Identify ~ 20 key events for further analysis, e.g. source regions, STILT back trajectories, PM filter-based speciation, weather classification, duration, any additional characterization based on supplemental TCEQ data.
   a) *Source region analysis*. The Stochastic Time-Inverted Lagrangian Transport (STILT) simulates how an ensemble of theoretical atmospheric particles would move backwards from a receptor location (Lin et al., 2003). By taking an average of the trajectories of all the particles the footprint of the source region impacting the receptor site can be identified. Professor Hallar's group at University of Utah has previously used the STILT to identify dust source regions in the western US dust (Lacher, Hallar et al. 2025). Here, to minimize computational resources and student effort, STILT will only be run for the 20 dust events selected for further analysis.
   b) *Weather characterization*. Each event will be characterized by weather system using the same approach as recent Texas dust studies (Kelley and Ardon-Dryer 2021, Rodriguez Ortiz, Mehra et al. 2025) which utilize key words in the Area Forecast Discussions (AFD) of the local NWS to separate between synoptic and mesoscale events. There is an extensive list of notations in the METAR datasets (https://pilotinstitute.com/how-to-read-metar/), which will be used in addition to text in the AFD to indicate weather conditions including but not limited to cold fronts, cyclones, thunderstorms, convection, etc.
   c) *Aerosol characterization.* When available, the PM speciation on days with dust events will be incorporated into the analysis. Combined with the STILT trajectory analysis of source regions, the elemental analysis can help to inform mineral composition from the source regions. Aerosol optical properties are available for periods of 2019-2021. Previous studies have used aerosol optical properties to evaluate aerosol mixing and sources (Cappa, Kolesar et al. 2016, Schmeisser, Andrews et al. 2017). The time resolution of the aerosol optical properties (5 min) matches the time resolution of the PM_{10} and $PM_{2.5}$ TEOM, allowing for a clear match during the dust event.
   d) *Other dust event characteristics based on TCEQ data.* Meteorological data (wind speed, wind direction, temperature) on equivalent time resolution as the PM_{10} and $PM_{2.5}$ TEOM datasets will inform weather conditions during the dust events. Trace gas data (e.g. CO) can be used to understand potential source mixing with biomass burning or local combustion.
   e) *Satellite data product.* If significant AOD is present during these 20 dust events, numerous satellite data products are available to provide a spatial extent of the dust (as demonstrated in Figure 1). These spatial characteristics will be combined with the STILT back trajectory analysis to provide a more robust source region analysis.
4) Estimate dust impact on annual PM_{10} and $PM_{2.5}$
   a) *PMF of speciated PM (limited by collection days):* For analysis of dust contributions to annual PM2.5 concentration, a positive matrix factorization (PMF) will be completed on all available speciated PM data from TCEQ sites in El Paso (2001-2025). This will provide sufficient samples for PMF analysis

and an estimate of the annual contribution of dust to PM in El Paso. These results will be compared to the IMPROVE algorithm for calculating dust contribution using X-ray fluorescence (XRF) elemental analysis of filter samples (e.g. (Malm, Sisler et al. 1994)). Sheesley recently completed a PMF analysis for TCEQ using PM speciation data from the North Wayside site near Houston (Sheesley and Usenko 2024)] and is experienced in doing this analysis.

b) For years with 5 min PM_{10} and $PM_{2.5}$ data, calculate annual average with and without dust event peak removal. This will be accomplished by developing an algorithm to detect and remove PM peaks and smooth the baseline during dust events. The results of this analysis will be presented with the PMF dust contribution results to provide a more detailed analysis of dust contribution to PM in El Paso. This analysis would be limited to dust events that are of short duration, with defined PM peaks.

5) Compare event identification across methods to characterize strengths and weaknesses of each method (remote sensing, NWS, and in-situ aerosol)
   a) We will discuss strengths and weaknesses of each method including time, efficiency, ability for automation, positive and negative bias for number of events identified and availability of data. For example, what events are missed by remote sensing analysis and why (cloud cover, satellite overpass time), and what are the limitations of identification by real time PM measurements (false positives, requirement to set thresholds). Additionally, we can assess how dust event intensity as measured by AOD compares to in-situ PM measurements to better understand how satellite retrievals relate to surface conditions. Similarly, we can compare visibility-based assessment of dust from ASOS to the PM concentrations at TCEQ sites to consider both location-based and methodological differences in dust intensity for these two datasets.

Utility for TCEQ:
The findings from this project will primarily be applicable to TCEQ for exceptional event characterization and PM attainment analysis. Our detailed characterization of ~20 key dust events will provide a template of key analyses that can be duplicated by TCEQ for exceptional event requests; this will be included in Tasks 3 and 5. If TCEQ has specific dust event requests, those can be communicated to the PIs during the course of the project. Tasks 2 and 4 will specifically address PM attainment in El Paso. In Task 2 we will provide frequency analysis (e.g. Pareto chart and/or flow chart) to identify the atmospheric conditions which most frequently result in dust storms.

2. Organization and Responsibilities

2.1 Key Personnel

2.1.1 Rebecca Sheesley (PI), Baylor University.

- Coordinates the operations of the project and is the primary contact person

- Leads reporting requirements (SOW, QAPP, interim and final reports)
- Works with Baylor graduate students to perform data analysis focusing on in-situ aerosol, trend analysis, PM speciation, dust impacts, and comparison across methods
- Assist QA lead as needed

2.1.2 Gannet Hallar, University of Utah

- Assists with reporting requirements (SOW, QAPP, interim and final reports)
- Works with UU graduate students to perform data analysis focusing on remote sensing, trend analysis, STILT, source regions, and comparison across methods

2.1.3 Elisabeth Andrews, CIRES, University of Colorado.

- Assists with reporting requirements (SOW, QAPP, interim and final reports)
- Performs data analysis focusing on NWS, trend analysis, weather classification, dust impacts, and comparison across methods
- QA lead

2.1.4 Erin Boedicker, CIRES, University of Colorado**.**

- Assists with reporting requirements (SOW, QAPP, interim and final reports)
- Performs data analysis focusing on NWS, trend analysis, weather classification, dust impacts, and comparison across methods

2.2 Project Schedule

Deliverables	Fall 2026	Winter 2027	Spring 2027	Summer 2027
Task 1: Dust event identification				
Task 2: Trend analysis				
Task 3: Detailed characterization of 20 events				
Task 4: Inventory of annual dust contribution				
Task 5: Final comparison of methods				

Deliverables	**Due Dates**
Statement of Work QAPP Budget Justification Abstract	**May 14, 2026**
Progress Reports	**10th of each month, Sept 2026 – Aug 2027**
Quarterly Report 1 Dust event identification (Task 1), preliminary results	**October 31, 2026**

Quarterly Report 2 Dust event identification (Task 1)	**January 31, 2027**
Quarterly Report 3 Trend analysis (Task 2) Detailed characterization of 20 events (Task 3)	**April 30, 2027**
Quarterly Report 4 Inventory of annual dust contribution (Task 4) Final comparison of methods (Task 5)	**July 31, 2027**
Draft and Final Reports Draft Final Report Final Report	 **August 1, 2027** **August 31, 2027**

3. Scientific Approach

3.1 Secondary data

This project will utilize three different types of datasets: remote sensing, in-situ aerosol and air quality observations, and data archives from the National Weather Service. This project is focused on El Paso, TX and the secondary data will also be focused on this area. The project will focus on the time period 2000-2025.

3.2 Sources for Secondary Data

For the remote sensing analysis, MODIS AOD observations will be obtained from the Collection 6.1 MOD08 (Terra) Level 3 global atmosphere product containing gridded 1° by 1° daily averages of spectral AOD. Additionally, we will leverage ground based remote sensing instrumentation available in Texas. Specifically, the US Department of Agriculture's UV-B Monitoring and Research Program (UVMRP) has sites in El Paso, Houston, Panther Junction, and Seguin Texas, and two decades of data is available for each of these sites. This network includes visible Multifilter Rotating Shadowband Radiometers (vis-MFRSR) (Bigelow, Slusser et al. 1998). A high-quality time series of vis-MFRSR cloud-screened and calibrated AOD is created at numerous wavelengths, and thus an EAE, can be calculated.

For the analysis based on weather observations, we will follow a methodology previously used to identify dust events based on National Weather Service (NWS) data archives (e.g., (Hahnenberger and Nicoll 2012, Kelley and Ardon-Dryer 2021)). We will download Meteorological Aerodrome Reports (METARs) for the time period 2000-2025 which are freely available from the Iowa Environmental Mesonet website (Iowa Environmental Mesonet, 2020). METAR observations are primarily based at airports as the information is critical for aviation safety. These files include standard meteorological information (e.g., temperature, relative humidity, pressure, wind speed, wind direction, visibility) from the NWS Automated Surface Observation System (ASOS). The files also include present weather codes, some of which are automated (rain, mist, fog) and some of which (e.g., thunderstorm, dust, etc.) are inserted by an official weather observer. We will use the ASOS and METAR data for a 100-mile radius around El Paso (a zoomable map for US sites is provided by the NWS: https://www.weather.gov/asos). This 100-mile radius includes the observations in El Paso as well as additional stations in Texas, New Mexico, and Mexico. METAR data is available in 5min time resolution (sometimes 1 min), which will also allow assessment of the duration of identified dust events.

For the in-situ aerosol-based identification, we will use TCEQ datasets from monitoring sites in El Paso, including 5-minute TEOM data for PM10 and PM2.5, 24hr filter speciation data. We will also use aerosol optical data from TCEQ BC2 projects (AQRP project 19-031 and TCEQ grants 582-18-81339). We will add trace gas data (e.g. CO, when available) to evaluate potential source mixing for the detailed characterization of 20 events.

Stochastic Time-Inverted Lagrangian Transport (STILT) simulates how an ensemble of theoretical atmospheric particles would move backwards from a receptor location (Lin, Gerbig et al. 2003). By taking an average of the trajectories of all the particles the footprint of the source region impacting the receptor site can be identified. Professor Hallar's group at University of Utah has previously used STILT to identify dust source regions in the western US dust (Lacher et al., 2025). Here, to minimize computational resources and student effort, STILT will only be run for the 20 dust events selected for further analysis.

4. Quality Metrics

4.1 Secondary data quality requirements

The secondary data quality requirements for datasets sourced from TCEQ, NASA, previous PI field campaigns funded by TCEQ (BC2) and NWS/METAR are qualitative and are based on the past experience of the principal investigator and the method used. These data sets are expected to have been validated prior to posting on TCEQ, NWS/METAR and NASA data archives. The appropriateness of the data to be used in the analysis is the responsibility of the investigator who is performing the analysis. Should unexpected data, such as data out of expected ranges, be found during the course of this analysis project, determination on the suspect data will be made prior to moving forward with analysis.

4.2 Data Quality Determination

The project PIs will, along with the staff and students participating in the analysis, determine the appropriateness of the data used for the various analyses. As all data used will have been determined to be of final, publishable quality by TCEQ, NWS, NASA, or the original PI responsible for collection, the project team will largely rely on the designation of final data as having met the respective QA/QC requirements.

4.3 Data Quality Requirements

No project-specific data quality requirements exist. The quality of the secondary data was not evaluated by NWS, NASA, EPA or TCEQ. A disclaimer will be added to any project deliverable stating that "*The quality of the secondary data used in this analysis has not been evaluated by NWS, NASA, or EPA for this specific application.*"

4.4 Audits of Data Quality

To meet the 10 percent audit of data quality requirement stipulated by TCEQ contract requirements for a Category III QAPP, the project PIs will examine the analytical data by reviewing the data for key species, as appropriate. Outliers and suspicious samples will be identified and the data sequestered and/or flagged as necessary. Field and lab notes will be considered for all samples. In carrying out data and statistical analyses, the project PIs will ensure the data products are interpretable to an informed reader. Results may be compared to results in published technical literature. Additionally, a member of the research team who did not conduct the input data processing will review the input and output data for quality assurance purposes, which will meet or exceed the 10 percent audit of data quality requirement. The QA audits will be led by Elisabeth Andrews.

5. Data Analysis, Interpretation, and Management

The data analyses performed during the execution of this project will use statistical analysis techniques and the back trajectory analysis described in the associated statement of work as tools.

5.1 Data Reporting Requirements

These data analysis results may be used by decision makers at the TCEQ in order to inform potential particulate matter control strategies for the El Paso area. This project will perform data analysis, using data collected by TCEQ, NASA and NWS for the period of 2000-2025 and during the TCEQ funded BC2 field campaigns in El Paso in 2019, 2020, and 2021. The data will initially be used in the highest time resolution available. To match datasets, high time resolution data will be averaged to the lower time resolution. For example, the TEOM PM data and aerosol optical properties will be averaged to match 24-hr aerosol chemical composition from filter-based datasets. There will also be data averaging to understand long – term climatological trends, e.g. monthly, annual.

5.2 Validation Process

Datasets from NASA, TCEQ and NWS are assumed to have been validated prior to inclusion in the archived datasets. Field data for 2019 – 2021 BC2 field campaigns in El Paso were validated as part of the data collection project and involved evaluating the data with respect to Quality Assurance/Quality Control criteria based in part on calibrations and instrument performance.

5.3 Data Analysis

Both descriptive (e.g. mean, median, standard error, minimum and maximum, correlation, positive matrix factorization, etc.) and inferential (hypothesis test, confidence interval, confidence limits, etc.) analysis of the data may be used for this project.

For trends, we will use methodology developed within Dr. Hallar's research group (Lambert, Hallar et al. 2020) for MODIS AOD observations. The MODIS data will be obtained from the Collection 6.1 MOD08 (Terra) Level 3 global atmosphere product containing gridded 1° by 1° daily averages of spectral AOD derived using the dark target (DT) over land algorithm for bands centered at 470, 550, and 660 nm (Levy, Mattoo et al. 2013). Dust events (AOD_{dust}) will be segregated from other high AOD events (e.g., due to wildfires) using EAE < 0.75.Trends in AOD_{dust} over the MODIS record will be calculated following the nonparametric Theil-Sen Estimator method (Sen 1968, Theil 1992). The AOD_{dust} trends will be compared to median AOD_{dust} values in 1° by 1° grid boxes. This spatial analysis will help identify specific areas where dust impacts may be increasing.

Following a similar approach to McClure and Jaffe (2018), quantile regression will be used to assess trends in extreme events. This method was developed by Koenker and Bassett (1978). Quantile regression applies asymmetric weighting at different quantiles and regresses the entire dataset at specific quantiles to estimate the rate of change across the entire distribution of data (Koenker and Hallock 2001, Koenker 2005).

5.4 Data Storage

The final analysis and data will be included in the final report. Files generated in the production of the final report will be stored at each institution for backup.

For STILT analysis, a petabyte-scale data repository is managed by the University of Utah's Center for High Performance Computing (CHPC). CHPC provides support for large-scale computer systems, networking, data storage, and optimization of the use of such systems as well as the source code to run on HPC systems. CHPC works with faculty members and research groups at the University of Utah to provide tailored support for each faculty's computing needs. Researchers in the Department of Atmospheric Sciences have extensive experience retrieving, archiving, and disseminating observational data from all types of sensing systems. The CHPC supports two types of disk-based data storage: (1) NFS-mounted disks and (2) an object data store (Pando) similar to that available from commercial cloud providers. NFS-mounted disks provide internal users with CHPC accounts convenient access, while Pando allows external users convenient access via the web. To avoid data loss, all data will be archived on both systems.

6. Reporting

The final analysis will be included in the final report and delivered to TCEQ at the end of the project. Interim reports will include preliminary progress on each task, while the final report will include the final version of analysis for each task.

6.1 Deliverables

Deliverables	**Due Dates**
Statement of Work QAPP Budget Justification Abstract	**May 14, 2026**
Progress Reports	**10th of each month, Sept 2026 – Aug 2027**
Quarterly Report 1 Dust event identification (Task 1), preliminary results	**October 31, 2026**
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Quarterly Report 3 Trend analysis (Task 2) Detailed characterization of 20 events (Task 3)	**April 30, 2027**
Quarterly Report 4 Inventory of annual dust contribution (Task 4)	**July 31, 2027**
Draft and Final Reports Draft Final Report Final Report	 **August 1, 2027** **August 31, 2027**

6.2 Final Report

A Draft Report and a Final Report shall be delivered to the TCEQ Project Manager no later than the deliverable due date. The Final Report will include the following components:

1. An abstract.
2. A brief introduction that discusses the project's background and objectives. Include relationships to other studies if applicable.
3. A final update report on each individual task.
4. Recommendations, if any, for what should be considered next as a new study.
5. An analysis section (as described below).

The Final Report will provide a comprehensive overview of activities undertaken and any data collected and analyzed. The abstract (1) will give a brief overview of the major activities and key findings of the project. The introduction section (2) will include a brief discussion of the importance of wind-blown dust to air quality in West Texas. The final update for each task in the SOW (3) will include a summary of the pertinent analyses conducted under that task and which subsections of the analysis section it supported. Additionally, any shortfalls, limitations, encountered problems and associated corrective actions and/or relevant statistics including data or parameter completeness, accuracy, and precision will be discussed. The recommendations section (4) will discuss follow-up research activities that would build upon this study or fill in information gaps.

The analysis section (5) will include an Executive Summary highlighting the most policy relevant and scientifically relevant findings and conclusions that reference later sub-sections, a brief methods section that outlines the instrumentation that collected the analyzed dataset and dates sampled, and a body that includes sub-sections on each key finding. The body will be organized by conclusion or finding, not by task or measurement platform. Each sub-section of the body will include relevant statistics and analysis results related to that analysis topic. The analysis section will be written for a semi-technical audience with an emphasis on policy relevant information.

The first draft of the report will be an outline of the report. It will detail the planned analysis techniques for each task and the analysis topics that will be discussed in the analysis section.

7. References

. "ASOS-AWOS-METAR data." Iowa Environmental Mesonet 2020. Retrieved Jan 8, 2026, from METAR data link.

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Scope of Work

Project #26-001
Longterm trends in dust sources in West Texas

Prepared for

Air Quality Research Program (AQRP)
The University of Texas at Austin

By

Rebecca J Sheesley
Baylor University

Gannet Hallar
University of Utah

Elisabeth Andrews and Erin Boedicker
CIRES, University of Colorado

DATE
June 4, 2026

QA Requirements: Audits of Data Quality: 10% Required
Report of QA Findings: Required in Final Report

NOTE: The Workplan package consists of three independent documents: Scope of Work, Quality Assurance Project Plan (QAPP), and budget and justification. Please deliver each document (as well as all subsequent documents submitted to AQRP) in Microsoft Word format.

QA Requirements: Technical Systems Audits - Not Required for the Project
Audits of Data Quality – 10% Required

Approvals

This Scope of Work was approved electronically by:

Signed by:
David Sullivan
0F1393AEF40744E...

2026-07-09 | 11:25:02 CDT

David Sullivan — Date
Project Manager, Texas Air Quality Research Program

This Scope of Work was approved electronically by:

Signed by:
Laramie Mahan
21607FF2D5EB4FC...

2026-07-09 | 11:41:14 CDT

Laramie Mahan — Date
Project Liaison, Texas Commission on Environmental Quality

This Scope of Work was approved electronically by:

Signed by:
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2026-07-09 | 13:04:00 CDT

Rebecca Sheesley, Principal Investigator — Date
Baylor University

Table of Contents

1. Abstract

The focus of the current proposal is identification of dust events in El Paso using three complementary methods for 2000-2020. This will enable a multi-faceted analysis of long-term trends and a comparison of the strengths and weaknesses across these methods, which address Texas AQRP Research Priority: long term trends in dust sources in West Texas. We will apply several different methods for identification and characterization of dust events: (1) remote sensing from satellite observations (Lambert, Hallar et al. 2020) and surface-based column measurements (Hallar, Petersen et al. 2015), (2) extraction of dust event descriptions from National Weather Service (NWS) reports (Kelley and Ardon-Dryer 2021), and (3) assessment of dust contributions to particulate matter (PM) from in-situ aerosol observations (e.g. TCEQ PM_{10}, $PM_{2.5}$ and PM speciation data; (Sheesley and Usenko 2024, Rodriguez Ortiz, Mehra et al. 2025)). Each method utilizes a different dataset and, when combined, this project will offer a well-rounded characterization of dust events. We plan to compare results of dust event identification across these three methods for 2000-2020 in El Paso, TX to better understand how the input data informs dust event identification and characterization.

2. Background

Wind-blown dust is a long standing issue for air quality in Southwest and Great Plains (Hand, White et al. 2016, Achakulwisut, Shen et al. 2017, Lambert, Hallar et al. 2020, Kelley and Ardon-Dryer 2021, Aryal and Evans 2022, Guzman-Gonzalez, Fitzgerald et al. 2024, Ardon-Dryer 2025, Line, Turner et al. 2025, Rodriguez Ortiz, Mehra et al. 2025). El Paso is often included in larger regional studies on dust climatology, but the direct impact on PM2.5 for this city needs further study. There are several different methods that have been employed to characterize the primary driving factors in dust events, the source regions, the extent, the duration and the impact on local air quality. In this study we will be utilizing three different methods.

Remote sensing (satellite and ground-based) can be used to identify dust events (e.g., (Chu, Kaufman et al. 2002)). Here we will use two remote sensing techniques. First, we will identify dust events using MODIS satellite data as was done in Lambert et al. (2020). Second, we will use ground-based column properties derived from the USDA UV-B network as was done in Hallar et al. (2015).

Our second method will use information from NWS report archives as in Kelley and Ardon-Dryer (2021), which was completed for Lubbock, TX. This method aligns dust event identification with meteorological characterization and is useful for estimating duration of events as well. As this method has already been applied in West Texas, there would be opportunity for comparison between El Paso and Lubbock or West Texas dust event identification (Kelley and Ardon-Dryer 2021, Guzman-Gonzalez, Fitzgerald et al. 2024).

Finally, we will utilize the significant archive of in-situ PM monitoring data available for El Paso. There is real time observation data using a tapered element oscillating microbalance (TEOM) for PM_{10} and $PM_{2.5}$, which is critical for understanding dust influence of short events (Ardon-Dryer 2025, Rodriguez Ortiz, Mehra et al. 2025). Additionally, there is 24hr $PM_{2.5}$ mass and speciation data, including crustal elements, which are important in determining potential dust sources (Hand, White et al. 2016). Finally, in 2019 and 2020, there is aerosol optical property data from the BC2 network operated by PI Sheesley with support from AQRP and TCEQ, respectively. These combined aerosol datasets will allow for identification and characterization of dust events in El Paso for 2000-2020, analysis of trends in $PM_{2.5}$ that can be compared to previous efforts focused on IMPROVE monitoring sites (Hand, White et al. 2016) and a better understanding of the impact of large dust events on local $PM_{2.5}$.

3. Objectives

1.1 Purpose and Objectives

We will apply several different methods for identification and characterization of dust events: (1) remote sensing from satellite observations (Lambert, Hallar et al. 2020) and surface-based column measurements (Hallar, Petersen et al. 2015), (2) extraction of dust event descriptions from National Weather Service (NWS) reports (Kelley and Ardon-Dryer 2021), and (3) assessment of dust contributions to particulate matter (PM) from in-situ aerosol observations (e.g. TCEQ PM_{10}, $PM_{2.5}$ and PM speciation data; (Sheesley and Usenko 2024, Rodriguez Ortiz, Mehra et al. 2025)). Each method utilizes a different dataset and, when combined, this project will offer a well-rounded characterization of dust events. We plan to compare results of dust event identification across these three methods for 2000-2020 in El Paso, TX to better understand how the input data informs dust event identification and characterization.

Tasks:

1) Conduct dust event identification using three different methods for 2000-2020 in El Paso (remote sensing, NWS, and in-situ aerosol)
2) Trend analysis
    a) Number, duration, and PM concentration trend analysis for El Paso for events identified by different methods in Task 1
3) Identify ~ 20 key events for further analysis, e.g. source regions, STILT back trajectories, PM filter-based speciation, weather classification, duration, any additional characterization based on supplemental TCEQ data
4) Estimate dust impact on annual PM_{10} and $PM_{2.5}$
    a) Positive Matrix Factorization (PMF) of speciated PM (limited by collection days)
    b) For years with 5 min PM_{10} and $PM_{2.5}$ data, calculate annual average with and without dust event peak removal
5) Compare event identification across methods to characterize strengths and weaknesses of each method (remote sensing, NWS, and in-situ aerosol)

Utility for TCEQ:

The findings from this project will primarily be applicable to TCEQ for exceptional event characterization and PM attainment analysis. Our detailed characterization of ~20 key dust events will provide a template of key analyses that can be duplicated by TCEQ for exceptional event requests; this will be included in Tasks 3 and 5. If TCEQ has specific dust event characterization requests, those can be communicated to the PIs during the course of the project. Tasks 2 and 4 will specifically address PM attainment in El Paso. In Task 2 we will provide frequency analysis (e.g. Pareto chart and/or flow chart) to identify the atmospheric conditions which most frequently result in dust storms.

4. Task Descriptions

Task 1: Dust identification

Conduct dust event identification using three different methods for 2000-2025 in El Paso (remote sensing, NWS, and in-situ aerosol)

a) *Remote sensing*; Using the methodology developed within Dr. Hallar's research group (Lambert, Hallar et al. 2020), MODIS Aerosol Optical Depth (AOD) observations will be obtained from the Collection 6.1 MOD08 (Terra) Level 3 global atmosphere product containing gridded 1° by 1° daily averages of spectral AOD (Levy, Mattoo et al. 2013). Temporal resolution is roughly 2 days. An extinction Ångström exponent (EAE) constraint will be used to segregate dust events from other high AOD events (e.g., due to wildfires). EAE is inversely related to particle size. Lambert et al (2020) used AE<0.75 in their study, but EAE thresholds of 0.9, 0.5, and 0.3 have also been shown to separate dust from other aerosol types depending on site specifics (Moulin, Dulac et al. 1997, Moulin, Guillard et al. 1997, Eck, Holben et al. 1999, Pinker, Pandithurai et al. 2001, Gautam, Liu et al. 2009). Additionally, we will leverage ground based remote sensing instrumentation available in Texas. Specifically, the US Department of Agriculture's UV-B Monitoring and Research Program (UVMRP) has sites in El Paso, Houston, Panther Junction, and Seguin Texas, and two decades of data is available for each of these sites. This network includes visible Multifilter Rotating Shadowband Radiometers (vis-MFRSR) [Bigelow et al., 1998]. A high-quality time series of vis-MFRSR cloud-screened and calibrated AOD is created at numerous wavelengths, and thus an EAE, can be calculated. As with the satellite analysis, dust events are clearly distinguished using an EAE constraint [Hallar et al., 2015]. Dr. Haller's paper (Lambert et al, 2020) will be used as a reference for starting points of EAE, however, that analysis was based on agricultural dust. We will likely modify the EAE constraint values based on cases of known events that in El Paso during our time period (2000-2025) as we may expect more mineral dust in this region. We will make recommendations for future use for thresholds that are valuable for understanding PM in this region.
b) *National Weather Service*: We will follow a methodology previously used to identify dust events based on National Weather Service (NWS) data archives (e.g., (Hahnenberger and Nicoll 2012, Kelley and Ardon-Dryer 2021)).

Specifically, we will download Meteorological Aerodrome Reports (METARs) for the time period (2000-2020) which are freely available from the Iowa Environmental Mesonet website [Iowa Environmental Mesonet, 2020]. METAR observations are primarily based at airports as the information is critical for aviation safety. These files include standard meteorological information (e.g., temperature, relative humidity, pressure, wind speed, wind direction, visibility) from the NWS Automated Surface Observation System (ASOS). The files also include present weather codes, some of which are automated (rain, mist, fog) and some of which (e.g., thunderstorm, dust, etc.) are inserted by an official weather observer. We will use the ASOS and METAR data for a 100-mile radius around El Paso (a zoomable map for US sites is provided by the NWS: https://www.weather.gov/asos). This 100-mile radius includes the observations in El Paso as well as additional stations in Texas, New Mexico, and Mexico. METAR data is available in 5min time resolution (sometimes 1 min), which will also allow assessment of the duration of identified dust events. The ASOS/METAR observations do not directly indicate PM loading, but visibility is an indicator of dust event intensity, with lower visibility indicating a bigger dust event. PM loading can be estimated from visibility (e.g., (Li, Kang et al. 2022)).

c) *In-situ aerosol*: The real time TEOM data provides an opportunity to detect dust events on any day, but has the potential to be less specific. During the TCEQ BC2 projects, we identified dust events based on enhancements above the average scattering coefficient and scattering Ångström exponent (SAE) less than 0.5 (Sheesley, Usenko et al. 2024); we will use the 2019-2021 in-situ aerosol optical data to develop an identification algorithm to target large-scale events using the 2000-2025 TEOM data in El Paso. We will identify dust events based on changes in PM10 concentration, PM10:PM2.5 ratios, and threshold values for PM. Threshold values for PM concentration and duration of elevated PM will be applied to minimize false positives and to more effectively target large-scale events. PM speciation will be used as available to confirm dust event identification. Thresholds for PM enhancement and duration of event will take into account local characteristics and be cross-referenced with the other dust identification methods. Since we have 2019, 2020 and 2021 aerosol optical data, we will use those years to develop a threshold algorithm for the long term data (e.g. PM10, wind, PM2.5) to enable automated identification of dust events for years with only PM2.5 and PM10.

Task 2 Trend analysis

Number, duration, and PM concentration trend analysis for El Paso for events identified by different methods in Task 1.

a) Here, we will estimate trends in dust events based on several event characteristics: (i) number of events/year, (ii) mean (and median) duration of events/year and (iii) mean (and median) intensity of events/year. The proxy for intensity will depend on the specific dataset: for example – METAR data dust intensity would be described by visibility, air quality data dust intensity would be described by PM loading, and remote sensing data dust intensity by AOD. Annual trends require a time series of at least 10 years (e.g., (Weatherhead, Reinsel et al. 1998)), so we will be able to assess trends for all datasets except the BC2 campaign optical data. To assess trends in duration, we will need both a long enough time series and high-resolution data so that duration of each event can be determined. The significance of each trend will be evaluated by looking at correlation coefficients as well as other standard statistical tests (e.g., parametric *t* test assuming one degree of freedom per year).

Task 3 Detailed characterization of 20 events

We will identify ~ 20 key events for further analysis, e.g. source regions, STILT back trajectories, PM filter-based speciation, weather classification, duration, any additional characterization based on supplemental TCEQ data

a) *Source region analysis*. The Stochastic Time-Inverted Lagrangian Transport model (STILT) simulates how an ensemble of theoretical atmospheric particles would move backwards from a receptor location (Lin et al., 2003). By taking an average of the trajectories of all the particles the footprint of the source region impacting the receptor site can be identified. Professor Hallar's group at University of Utah has previously used the STILT model to identify dust source regions in the western US dust (Lacher, Hallar et al. 2025). Here, to minimize computational resources and student effort, STILT will only be run for the 20 dust events selected for further analysis.

b) *Weather characterization*. Each event will be characterized by weather system using the same approach as recent Texas dust studies (Kelley and Ardon-Dryer 2021, Rodriguez Ortiz, Mehra et al. 2025) which utilize key words in the Area Forecast Discussions of the local NWS to separate between synoptic and mesoscale events.

c) *Aerosol characterization.* When available, the PM speciation on days with dust events will be incorporated into the analysis. Combined with the STILT trajectory analysis of source regions, the elemental analysis can help to inform mineral composition from the source regions. Aerosol optical properties are available for periods of 2019-2020. Previous studies have used aerosol optical properties to evaluate aerosol mixing and sources (Cappa, Kolesar et al. 2016, Schmeisser, Andrews et al. 2017). The time resolution of the aerosol optical properties (5 min) matches the time resolution of the PM_{10} and $PM_{2.5}$ TEOM, allowing for a clear match during the dust event.

d) *Other dust event characteristics based on TCEQ data.* Meteorological data (wind speed, wind direction, temperature) on equivalent time resolution as the PM_{10} and $PM_{2.5}$ TEOM datasets will inform weather conditions during the dust events. Trace gas data (e.g. CO) can be used to understand potential source mixing with biomass burning or local combustion.

e) *Satellite data product.* If significant AOD is present during these 20 dust events, numerous satellite data products are available to provide a spatial extent of the dust. These spatial characteristics will be combined with the

STILT back trajectory analysis to provide a more robust source region analysis.

Task 4 Estimate dust impact on annual PM_{10} and $PM_{2.5}$

a) *PMF of speciated PM (limited by collection days):* For analysis of dust contributions to annual PM2.5 concentration, a positive matrix factorization (PMF) model will be completed on all available speciated PM data from TCEQ sites in El Paso (2001-2020). This will provide sufficient samples for PMF analysis and an estimate of the annual contribution of dust to PM in El Paso. These results will be compared to the IMPROVE algorithm for calculating dust contribution using XRF elemental analysis of filter samples (e.g. (Malm, Sisler et al. 1994)). Sheesley recently completed a PMF analysis for TCEQ using PM speciation data from the North Wayside site near Houston (Sheesley and Usenko 2024)] and is experienced in using this model.

b) For years with 5 min PM_{10} and $PM_{2.5}$ data, calculate annual average with and without dust event peak removal. This will be accomplished by developing an algorithm to detect and remove PM peaks and smooth the baseline during dust events. The results of this analysis will be presented with the PMF dust contribution results to provide a more detailed analysis of dust contribution to PM in El Paso. This analysis would be limited to dust events that are of short duration, with defined PM peaks.

Task 5 Final comparison of methods

Compare event identification across methods to characterize strengths and weaknesses of each method (remote sensing, NWS, and in-situ aerosol)

a) We will discuss strengths and weaknesses of each method including time, efficiency, ability for automation, positive and negative bias for number of events identified and availability of data. For example, what events are missed by remote sensing analysis and why (cloud cover, satellite overpass time), and what are the limitations of identification by real time PM measurements (false positives, requirement to set thresholds). Additionally, we can assess how dust event intensity as measured by AOD compares to in-situ PM measurements to better understand how satellite retrievals relate to surface conditions. Similarly, we can compare visibility-based assessment of dust from ASOS to the PM concentrations at TCEQ sites to consider both location-based and methodological differences in dust intensity for these two datasets.

5. Project Schedule

Timeline for Task efforts	Fall 2026	Winter 2027	Spring 2027	Summer 2027
Task 1: Dust event identification				
Task 2: Trend analysis				
Task 3: Detailed characterization of 20 events				

Task 4: Inventory of annual dust contribution				
Task 5: Final comparison of methods				

AQRP requires certain reports to be submitted on a timely basis and at regular intervals. A description of the specific reports to be submitted and their due dates are outlined below.

One report per project will be submitted (collaborators will not submit separate reports), with the exception of the Financial Status Reports (FSRs). The lead PI will submit the reports, unless that responsibility is otherwise delegated with the approval of the Project Manager.

All reports will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources. Report templates and accessibility guidelines found on the navigation to the left. Please also refer to the AQRP Writing Guidance document.

Note: if a due date falls on a weekend, submission on the following Monday is acceptable.

ABSTRACT

At the beginning of the project, an Abstract will be submitted to the Project Manager for use on the AQRP website. The Abstract will provide a brief description of the planned project activities and will be written for a non-technical audience.

Due Date: Ten (10) business days after notice of intent to fund

QUARTERLY REPORTS

The Quarterly Report will provide a summary of the project status for each reporting period. It will be submitted to the Project Manager as a Word doc file. It will not exceed 3 pages and will be text only. No cover page is required. This document will be inserted into an AQRP compiled report to the TCEQ.

Due Dates:

Report	Period Covered	Due Date
Quarterly Report #1	**August, September, October 2026**	**October 31, 2026**
Quarterly Report #2	**November, December 2026, January 2027**	**January 31, 2027**

Quarterly Report #3	**February, March, April 2027**	**April 30, 2027**
Quarterly Report #4	**May, June, July 2027**	**July 31, 2027**

DUE TO PROJECT MANAGER

MONTHLY TECHNICAL REPORTS

Monthly Technical Reports (MTR) will be submitted monthly to the Project Manager and TCEQ Liaison as a Word doc using the Monthly Technical Report Template.

Due Dates:

Report	Period Covered	Due Date
Technical Report #1	**Project Start - August 31, 2026**	**September 10, 2026**
Technical Report #2	**September 1 - 30, 2026**	**October 10, 2026**
Technical Report #3	**October 1 - 31, 2026**	**November 10, 2026**
Technical Report #4	**November 1 - 30, 2026**	**December 10, 2026**
Technical Report #5	**December 1 - 31, 2026**	**January 10, 2027**
Technical Report #6	**January 1 - 31, 2027**	**February 10, 2027**
Technical Report #7	**February 1 - 28, 2027**	**March 10, 2027**
Technical Report #8	**March 1 - 31, 2027**	**April 10, 2027**
Technical Report #9	**April 1 - 30, 2027**	**May 10, 2027**
Technical Report #10	**May 1 - 31, 2027**	**June 10, 2027**
Technical Report #11	**June 1 - 30, 2027**	**July 10, 2027**
Technical Report #12	**July 1 - 31, 2027**	**August 10, 2027**

DUE TO PROJECT MANAGER

FINANCIAL STATUS REPORTS

Financial Status Reports (FSR) will be submitted monthly to the AQRP Grant

Manager (aqrp-grant-manager@austin.utexas.edu) by each institution on the project using the FSR Template.

Due Dates:

Report	Period Covered	Due Date
FSR #1	**Project Start - August 31, 2026**	**September 15, 2026**
FSR #2	**September 1 - 30, 2026**	**October 15, 2026**
FSR #3	**October 1 - 31, 2026**	**November 15, 2026**
FSR #4	**November 1 - 30, 2026**	**December 15, 2026**
FSR #5	**December 1 - 31, 2026**	**January 15, 2027**
FSR #6	**January 1 - 31, 2027**	**February 15, 2027**
FSR #7	**February 1 - 28, 2027**	**March 15, 2027**
FSR #8	**March 1 - 31, 2027**	**April 15, 2027**
FSR #9	**April 1 - 30, 2027**	**May 15, 2027**
FSR #10	**May 1 - 31, 2027**	**June 15, 2027**
FSR #11	**June 1 - 30, 2027**	**July 15, 2027**
FSR #12	**July 1 - 31, 2027**	**August 15, 2027**
FSR #13	**August 1 -31, 2027**	**September 15, 2027**
FSR #14	**Final FSR**	**October 15, 2027**

DUE TO GRANT MANAGER

DRAFT FINAL REPORT

A Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will include an Executive Summary. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources.

Due Date: August 1, 2027

FINAL REPORT
A Final Report incorporating comments from the AQRP and TCEQ review of the Draft Final Report will be submitted to the Project Manager and the TCEQ Liaison. It will be written in third person and will follow the State of Texas accessibility requirements as set forth by the Texas State Department of Information Resources.

Due Date: August 31, 2027

PROJECT DATA
All project data including but not limited to QA/QC measurement data, databases, modeling inputs and outputs, etc., will be submitted to the AQRP Project Manager within 30 days of project completion. The data will be submitted in a format that will allow AQRP or TCEQ or other outside parties to utilize the information.

AQRP WORKSHOP
A representative from the project will present at the AQRP Workshop, held August 2027 (exact date and time TBD) at UT Austin - West Pickle Research Campus.

6. Project Participants and Responsibilities

6.1 Key Personnel

6.1.1 Rebecca Sheesley (PI), Baylor University.

- Coordinates the operations of the project and is the primary contact person
- Leads reporting requirements (SOW, QAPP, interim and final reports)
- Works with Baylor graduate students to perform data analysis focusing on in-situ aerosol, trend analysis, PM speciation, dust impacts, and comparison across methods

6.1.2 Gannet Hallar, University of Utah

- Assists with reporting requirements (SOW, QAPP, interim and final reports)
- Works with UU graduate students to perform data analysis focusing on remote sensing, trend analysis, STILT, source regions, and comparison across methods

6.1.3 Elisabeth Andrews, CIRES, University of Colorado.

- Assists with reporting requirements (SOW, QAPP, interim and final reports)
- Performs data analysis focusing on NWS, trend analysis, weather classification, dust impacts, and comparison across methods

6.1.4 Erin Boedicker, CIRES, University of Colorado.

- Assists with reporting requirements (SOW, QAPP, interim and final reports)

- Performs data analysis focusing on NWS, trend analysis, weather classification, dust impacts, and comparison across methods

7. References

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Budget and Budget Justification

Project #26-001
Longterm trends in dust sources in West Texas

Prepared for

Air Quality Research Program (AQRP)
The University of Texas at Austin

By

Dr. Rebecca Sheesley
Baylor University

Dr. Elisabeth J. Andrews
The Regents of the University of Colorado

Dr. A. Gannet Hallar
University of Utha

DATE
Version #1

QA Requirements: Audits of Data Quality: 10% Required
Report of QA Findings: Required in Final Report

NOTE: The Workplan package consists of three independent documents: Scope of Work, Quality Assurance Project Plan (QAPP), and budget and justification. Please deliver each document (as well as all subsequent documents submitted to AQRP) in Microsoft Word format.

Approvals

This Budget was approved electronically by:

DocuSigned by:
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2026-07-09 | 11:15:26 CDT

RoseAnna Goewey | Date
Program Manager, Texas Air Quality Research Program

This Budget was approved electronically by:

Signed by:
David Sullivan
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2026-07-09 | 11:25:02 CDT

David Sullivan | Date
Project Manager, Texas Air Quality Research Program

This Budget was approved electronically by:

Signed by:
Laramie Mahan
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2026-07-09 | 11:41:14 CDT

Laramie Mahan | Date
Project Liaison, Texas Commission on Environmental Quality

Budget and Budget Justification

Please see below

Baylor University
Longterm trends in dust sources in West Texas
AQRP Budget

Principal Investigator: Dr. Rebecca Sheesley

Project Dates: 8/1/2026 to 8/31/2027

A. SENIOR PERSONNEL: PI, Co-PI						
	FirstName LastName	**Title**	**Monthly Rate**	**Fringe Rate**	**FTE / % Effort**	**Funds Requested**
1.	Rebecca Sheesley	PD/PI	$16,892	29.1%	0.04	$8,446
2.			$0	0.0%	0.00	$0
3.			$0	0.0%	0.00	$0
	TOTAL SENIOR PERSONNEL					**$8,446**
B. OTHER PERSONNEL (SHOW NUMBERS IN BOXES)						
1	0	Other Professionals / UPDATE TITLE	$0	0.0%	0.00	$0
2	0	Other Professionals / UPDATE TITLE	$0	0.0%	0.00	$0
3	1	Graduate Student	$2,750	8.8%	1.00	$33,000
	TOTAL OTHER PERSONNEL					**$33,000**
	TOTAL SALARIES AND WAGES (A+B)					**$41,446**
C. FRINGE BENEFITS (AUTOMATICALLY CALCULATED BASED ON ENTERED RATES)						
1.	Senior Personnel					**$2,458**
2.	Other Personnel					**$2,904**
	TOTAL FRINGE BENEFITS					**$5,362**
	TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)					**$46,808**
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5000)						
a)						$0
b)						$0
c)						$0
	TOTAL EQUIPMENT					**$0**
E. TRAVEL			**Cost per Trip**	**# of Trips**		
1.	Domestic (Incl. Canada, Mexico and U.S. Possessions)		$2,000	2		$4,000
2.	Foreign					$0
	TOTAL TRAVEL					**$4,000**
F OTHER DIRECT COSTS						
1.	Materials and Supplies					$2,500
2.	Professional Services - Idependent Contractors					$0
3.	Subcontracts (contracts will be issued by UT)					
	a) University of Utah					$36,520
	b) University of Colorado, Boulder					$39,681
	c)					$0
	d)					$0
4.	Tuition and Fees					$0
5.	Other					$0
	TOTAL OTHER DIRECT COSTS					**$78,701**
G. TOTAL DIRECT COSTS (A THROUGH F)						**$129,509**
H. TOTAL INDIRECT COSTS			**IDC Rate:**			**$34,794**
I. TOTAL COSTS						**$164,303**

NOTE: *Please indicate whether you are using Modified Total Direct Costs (MTDC) or Total Direct Costs (TDC) in the calculation of Indirect Costs (IDC).*

You may modify this template as needed to show calculation of direct or indirect costs or other project specific budgetary needs.

Baylor University
Longterm trends in dust sources in West Texas
AQRP Budget

Principal Investigator: Dr. Rebecca Sheesley

Project Dates: 8/1/2026 to 8/31/2027

A. SENIOR PERSONNEL: PI, Co-PI						
	FirstName LastName	**Title**	**Monthly Rate**	**Fringe Rate**	**FTE / % Effort**	**Funds Requested**
1.	Rebecca Sheesley	PD/PI	$16,892	29.1%	0.04	$8,446
2.			$0	0.0%	0.00	$0
3.			$0	0.0%	0.00	$0
	TOTAL SENIOR PERSONNEL					**$8,446**
B. OTHER PERSONNEL (SHOW NUMBERS IN BOXES)						
1	0	Other Professionals / UPDATE TITLE	$0	0.0%	0.00	$0
2	0	Other Professionals / UPDATE TITLE	$0	0.0%	0.00	$0
3	1	Graduate Student	$2,750	8.8%	1.00	$33,000
	TOTAL OTHER PERSONNEL					**$33,000**
	TOTAL SALARIES AND WAGES (A+B)					**$41,446**
C. FRINGE BENEFITS (AUTOMATICALLY CALCULATED BASED ON ENTERED RATES)						
1.	Senior Personnel					**$2,458**
2.	Other Personnel					**$2,904**
	TOTAL FRINGE BENEFITS					**$5,362**
	TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)					**$46,808**
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5000)						
a)						$0
b)						$0
c)						$0
	TOTAL EQUIPMENT					**$0**
E. TRAVEL			**Cost per Trip**	**# of Trips**		
1.	Domestic (Incl. Canada, Mexico and U.S. Possessions)		$2,000	2		$4,000
2.	Foreign					$0
	TOTAL TRAVEL					**$4,000**
F OTHER DIRECT COSTS						
1.	Materials and Supplies					$2,500
2.	Professional Services - Idependent Contractors					$0
3.	Subcontracts (contracts will be issued by UT)					
	a)					$0
	b)					$0
	c)					$0
	d)					$0
4.	Tuition and Fees					$0
5.	Other					$0
	TOTAL OTHER DIRECT COSTS					**$2,500**
G. TOTAL DIRECT COSTS (A THROUGH F)						**$53,308**
H. TOTAL INDIRECT COSTS			**IDC Rate:**	**15.000%**		**$7,996**
I. TOTAL COSTS						**$61,304**

NOTE: *Please indicate whether you are using Modified Total Direct Costs (MTDC) or Total Direct Costs (TDC) in the calculation of Indirect Costs (IDC).*

You may modify this template as needed to show calculation of direct or indirect costs or other project specific budgetary needs.

Baylor University
Longterm trends in dust sources in West Texas
AQRP Budget Justification

A. SALARIES

Dr. Sheesley, Principal Investigator, 0.04 FTE / %, will be responsible for project management and coordination among institutions. Sheesley will be responsible for project reporting. Sheesley will oversee the GRA at Baylor and will direct their activities. Sheesley will conduct the PMF analysis with the assistance of the Baylor GRA.

To be determined, Graduate Research Assistant (GRA), 1.00 FTE / %, will perform data acquisition and data analysis on the project. They will focus on dust aerosol characterization, including analysis of particulate matter concentration, speciation and optical properties (as available). They will also work on VIIRS/MODIS fire identification for key events. They will assist Sheesley with the PMF analysis of the PM data from El Paso.

B. FRINGE BENEFITS

Fringe benefits rates are based on Baylor's federally negotiated rates for the appropriate employee benefits level at the time of proposal submission. Total fringe benefits budget requested: $5,362

C. EQUIPMENT

N/A

D. OTHER DIRECT COSTS

MATERIALS AND SUPPLIES

Supplies are calculated at $2,500 per year for software and any necessary data storage needed for the data analysis. Total materials and supplies budgeted requested: $2,500.

TRAVEL

Funds are requested for project personnel to travel to an academic conference (e.g. AGU or AMS). Travel costs in this budget are based on sponsored research travel for previous similar trips and are calculated for the domestic travel of 2 people to take one trip. Total travel budget requested: $4,000.

TUITION

N/A

E. INDIRECT COSTS

The indirect cost rate of 15% of modified/total direct costs (MTDC/TDC) is being used by Baylor University as requested by the submission guidelines. MTDC is calculated as the total of direct costs, less [equipment in excess of $5,000 and less tuition remission applied to GRA salary]. Total indirect cost budget requested: $7,996

University of Colorado, Boulder
Longterm trends in dust sources in West Texas
AQRP Budget

Principal Investigator: **Elisabeth J Andrews**

Project Dates: **8/1/2026 - 8/31/2027**

			Monthly Rate	Fringe Rate	FTE / % Effort	Funds Requested
A. SENIOR PERSONNEL: PI, Co-PI						
	FirstName LastName	**Title**				
1.	Elisabeth Andrews	CU PI, Research Associate	$11,477	41.9%	1.35	$15,494
2.			$0	0.0%	0.00	$0
3.			$0	0.0%	0.00	$0
	TOTAL SENIOR PERSONNEL					**$15,494**
B. OTHER PERSONNEL (SHOW NUMBERS IN BOXES)						
1	1	Other Professionals / UPDATE TITLE	$7,319	41.9%	1.35	$9,881
2	0	Other Professionals / UPDATE TITLE	$0	0.0%	0.00	$0
3	0	Graduate Student	$0	0.0%	0.00	$0
	TOTAL OTHER PERSONNEL					**$9,881**
	TOTAL SALARIES AND WAGES (A+B)					**$25,375**
C. FRINGE BENEFITS (AUTOMATICALLY CALCULATED BASED ON ENTERED RATES)						
1.	Senior Personnel					**$6,486**
2.	Other Personnel					**$4,136**
	TOTAL FRINGE BENEFITS					**$10,622**
	TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)					**$35,997**
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5000)						
a)						$0
b)						$0
c)						$0
	TOTAL EQUIPMENT					**$0**
E. TRAVEL			**Cost per Trip**	**# of Trips**		
1.	Domestic (Incl. Canada, Mexico and U.S. Possessions)		$1,184	**1**		$1,184
2.	Foreign					$0
	TOTAL TRAVEL					**$1,184**
F OTHER DIRECT COSTS						
1.	Materials and Supplies					$0
2.	Professional Services - Idependent Contractors					$0
3.	Subcontracts (contracts will be issued by UT)					
	a)					$0
	b)					$0
	c)					$0
	d)					$0
4.	Tuition and Fees					$0
5.	Other	Page Charges for publications in refereed scientific journals				$2,500
	TOTAL OTHER DIRECT COSTS					**$2,500**
G. TOTAL DIRECT COSTS (A THROUGH F)						**$39,681**
H. TOTAL INDIRECT COSTS			**IDC Rate:**	**26.000%**		**$10,317**
I. TOTAL COSTS						**$49,998**

You may modify this template as needed to show calculation of direct or indirect costs or other project specific budgetary needs.

The Regents of the University of Colorado
Longterm trends in dust sources in West Texas
AQRP Budget Justification

A. SALARIES

Dr. Elisabeth J Andrews, Principal Investigator, 100% effort of 1.35 months, will be responsible for the overall coordination of the project at CU and the supervision of the other CU project personnel. The PI will also be responsible for performing trend analysis on the various time series utilized in the project which are long enough for trends to be calculated (length at least 10 years).

Dr. Erin Boedicker, Research Associate, 100% effort of 1.35 months, will be responsible for acquiring and National Weather Service Meteorological Aerodrome Reports (NWS METAR) and identifying dust events in the 2000-2020 time period.

FRINGE BENEFITS

Fringe benefits are calculated on requested salary per the University's federally negotiated Rate Agreement with the Department of Health and Human Services (DHHS) dated 9/30/2025. The Fixed rate for the period 7/1/2025-6/30/2026 is 40.8% of salary for full time professional & research personnel. Fringe Benefit rates are Fixed for the period 7/1/2025-6/30/2026 and Provisional thereafter until new rates are established. As rates are renegotiated yearly, an inflation rate of 2.6% has been included in the fringe benefit cost estimation to account for inevitable rate fluctuations that will occur throughout the project period. Inflation is included to provide an accurate estimate of potential fringe benefit costs, just as inflation is estimated for other direct costs. When salary is charged to the project, the actual Fixed or Provisional rate at that time will be applied. Total fringe benefits budget requested: $10,622

C. EQUIPMENT - NONE

D. OTHER DIRECT COSTS

TRAVEL

Travel funds are requested for a member of the project personnel to travel to Baylor University in Waco TX for a project meeting. This business meeting will be needed to discuss the efforts for, and the results of this project. The cost of travel is calculated for 3 days and includes airfare, lodging, per diem, and ground transportation. The cost of airfare and ground transportation is based on estimated costs. Lodging and per diem costs are based on rates established by the GSA for Waco TX.

Domestic	Cost/ Person	# Days	Year 1	Total
One member of the project personnel to travel to Baylor University in Waco TX for a project meeting				
No. Person-Trips			1	1
Airfare	$500		$500	$500
Lodging	$110	3	$330	$330
Per Diem	$68	3	$204	$204
Ground Transportation	$50	3	$150	$150
Total Domestic Travel			**$1,184**	**$1,184**
Total Travel			**$1,184**	**$1,184**

The Regents of the University of Colorado
Longterm trends in dust sources in West Texas
AQRP Budget Justification

Total travel budget requested: $1,184

Other
Publication Costs:
Publication costs for article processing page charges of $2,500 are included for dissemination of the research results in a refereed scientific journal

INDIRECT COSTS
Facilities and administration (F&A) costs are charged according to the University's federally negotiated rate agreement. The F&A cost rate for off-campus research is 26% of Modified Total Direct Cost (MTDC), predetermined for the period 7/1/2025 - 6/30/2028; provisional thereafter per HHS agreement dated 9/30/2025. MTDC consists of all salaries and wages, benefits, materials, supplies, travel, and up to the first $50,000 of subcontracts. MTDC shall exclude tuition, capital equipment, participant support costs, and the portion of subcontracts that exceed $50,000.

INFLATION RATES
The University of Colorado's current budget planning parameters include an annual inflation factor of 3.2% for salaries of investigators, post-doctoral researchers, graduate research assistants, and other professionals. Fringe Benefits are estimated to increase at 2.6% per year. Tuition and student fees are estimated to increase 3% per year and other direct costs such as travel can be inflated at 2.3% per year.

University of Utah
Longterm trends in dust sources in West Texas
AQRP Budget

Principal Investigator: A. Gannet Hallar

Project Dates: 8/1/2026 - 8/31/2027

A. SENIOR PERSONNEL: PI, Co-PI						
	FirstName LastName	**Title**	**Monthly Rate**	**Fringe Rate**	**FTE / % Effort**	**Funds Requested**
1.			$0	0.0%	0.00	$0
2.			$0	0.0%	0.00	$0
3.			$0	0.0%	0.00	$0
	TOTAL SENIOR PERSONNEL					**$0**
B. OTHER PERSONNEL (SHOW NUMBERS IN BOXES)						
1	0	Other Professionals / UPDATE TITLE	$0	0.0%	0.00	$0
2	0	Other Professionals / UPDATE TITLE	$0	0.0%	0.00	$0
3	1	Graduate Student	$4,000	9.0%	7.00	$28,000
	TOTAL OTHER PERSONNEL					**$28,000**
	TOTAL SALARIES AND WAGES (A+B)					**$28,000**
C. FRINGE BENEFITS (AUTOMATICALLY CALCULATED BASED ON ENTERED RATES)						
1.	Senior Personnel					**$0**
2.	Other Personnel					**$2,520**
	TOTAL FRINGE BENEFITS					**$2,520**
	TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)					**$30,520**
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5000)						
a)						$0
b)						$0
c)						$0
	TOTAL EQUIPMENT					**$0**
E. TRAVEL			**Cost per Trip**	**# of Trips**		
1.	Domestic (Incl. Canada, Mexico and U.S. Possessions)					$0
2.	Foreign					$0
	TOTAL TRAVEL					**$0**
F OTHER DIRECT COSTS						
1.	Materials and Supplies					$0
2.	Professional Services - Idependent Contractors					$0
3.	Subcontracts (contracts will be issued by UT)					
	a)					$0
	b)					$0
	c)					$0
	d)					$0
4.	Tuition and Fees					$6,000
5.	Other					$0
	TOTAL OTHER DIRECT COSTS					**$6,000**
G. TOTAL DIRECT COSTS (A THROUGH F)						**$36,520**
H. TOTAL INDIRECT COSTS			**IDC Rate:**	**54.000%**		**$16,481**
I. TOTAL COSTS						**$53,001**

NOTE: *Please indicate whether you are using Modified Total Direct Costs (MTDC) or Total Direct Costs (TDC) in the calculation of indirect Costs (IDC).*

You may modify this template as needed to show calculation of direct or indirect costs or other project specific budgetary needs.

University of Utah
Longterm trends in dust sources in West Texas
AQRP Budget Justification

A. SALARIES

TBD Graduate Research Assistant (GRA), 7 months effort, by a Ph.D. student will perform satellite identification of dust events. Total salary requested: $28,000

B. FRINGE BENEFITS

Fringe benefits rates are based on rates established by the University of Utah department of human resources. Total fringe benefits budget requested: $2,520

C. EQUIPMENT: NA

D. OTHER DIRECT COSTS:

TUITION

The University requires tuition remission to be budgeted for all Graduate Students working on sponsored projects. The tuition rate at the University of Utah, department of Atmospheric Sciences for one semester is $6,000. Total tuition budget requested: $6,000

INDIRECT COSTS

The indirect cost rate of 54% of modified/total direct costs (MTDC/TDC) is used as instructed by the AQRP's published proposal preparation instructions. MTDC is calculated as the total of direct costs, less [equipment in excess of $5,000 and less tuition remission applied to GRA salary]. Total indirect cost budget requested: $16,481

Total Request: $53,001