IDENTIFYING POLLUTANT SOURCES IN THE EL PASO REGION

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ABSTRACT

This research aims to identify pollutant sources using backward trajectories and dispersion simulated with the Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT), developed by NOAA's Air Resources Laboratory, in the El Paso region for 2024. The source-receptor analysis focuses on high $PM_{2.5}$ events (>35μg/m³), based on data collected by the Texas Commission of Environmental Quality (TCEQ). Uncertainties in the analysis are characterized in a number of ways, including: (a) evaluation of the meteorological data used to drive the HYSPLIT by comparison against meteorological observations in the region; and (b) evaluating the sensitivity of results to different model inputs and configurations (e.g., meteorological data, starting height, etc) On February 28 2024, a maximum daily value of $PM_{2.5}$ of 111.9μg/m³ was registered, and a simulation was also performed with a computationally efficient particulate matter source apportionment algorithm (Particulate Source Apportionment Technology, PSAT) HYSPLIT trajectory and dispersion simulations were also carried out to analyze this event, using meteorological data from the NOAA High-Resolution Rapid Refresh (HRRR Smoke) model and other NOAA models. This work is critical for identifying emission sources and informing the development of targeted air quality control strategies to mitigate pollution impacts in the region.

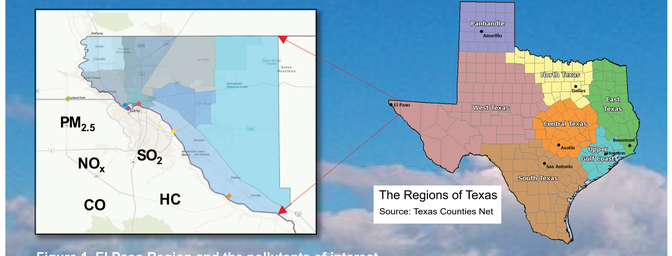


Figure 1. El Paso Region and the pollutants of interest.



Figure 2. Sources of pollution in El Paso, TX.
The pollution sources in El Paso, are the industries, the ports of entry, mining operations in El Paso and in other states, soil erosion.

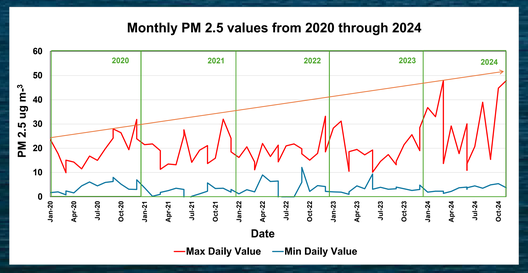


Figure 3. $PM_{2.5}$ increase from 2020 through 2024 in El Paso, TX.

METHODS

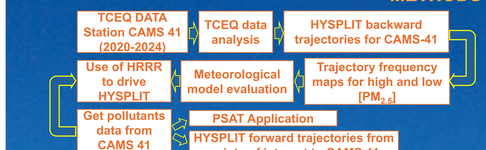


Figure 4. Flux diagram of the study

Table 1. Met Data for trajectories

Datasets for Trajectories	Spatial Resolution	Temporal Resolution	Trajectories Heights (1)	Trajectories Heights (2)
WRF-AWR 27	27 km	1hr	0.25 PBL	100m
NAM 12	12 km	3hrs	0.50 PBL	500m
HRRR	3 km	1hr	0.75 PBL	2000m
GDAS	1°	3hrs	All	All

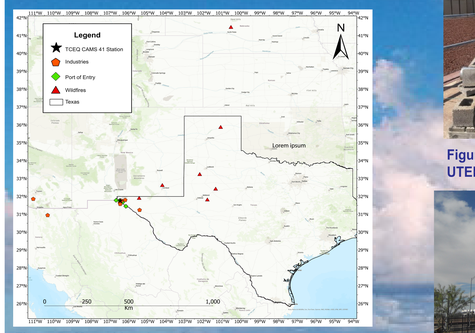


Figure 5. Map with points of interest.
TCEQ Station AMS 41 (black star), wildfires (red), industrial facilities (orange), ports of entry (green).

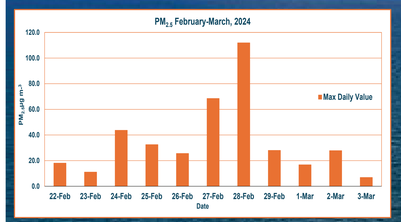


Figure 8. $PM_{2.5}$ values in El Paso.



Figure 6. Ceilometer in UTEP.



Figure 7. TCEQ Station CAMS 41, in Chamizal, El Paso. EPA site number 48-141-0044.

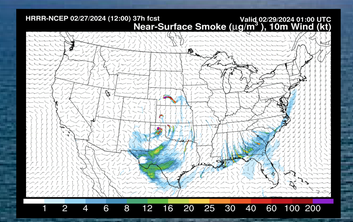


Figure 9. The High-Resolution Rapid Refresh model help us identify fires and smokes coming to El Paso

Figure 4 illustrates a flowchart outlining the methodological steps followed to derive air mass trajectories and dispersion using the HYSPLIT model. Various meteorological model output datasets and back-trajectory starting heights were analyzed as summarized in Table 1. A map highlighting the points of interest used in the HYSPLIT analysis is presented in Figure 5 , and the meteorological data from these datasets were compared with in situ measurements of planetary boundary layer (PBL) heights derived from the ceilometer located at UTEP and wind speed, wind direction, and relative humidity obtained from the TCEQ Station CAMS 41 at Chamizal in El Paso (Figure 6 & 7), these meteorological parameters were critical in determining the most suitable dataset for the study.

This presentation focuses on data from a specific event in 2024 (Figure 8), during which $PM_{2.5}$ concentrations exceeded 35 μg/m³, surpassing the daily average concentration limit set by the EPA. The HRRR-NECP Near-Surface Smoke product (Figure 9) was employed to rapidly identify potential smoke sources and wildfire locations, providing key inputs for subsequent dispersion analysis.

Dispersion modeling was conducted using a HYSPLIT script at various heights and particle numbers. The initial step involved calculating mass or unit concentrations per cubic meter to verify the dispersion pathways and arrival times. This was followed by running dispersion simulations for specific pollutant concentrations. The results from these analyses will aid in understanding pollutant transport dynamics and their potential impact.

PRELIMINARY RESULTS (Work in progress)

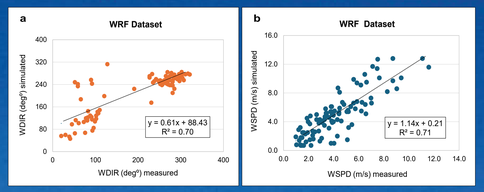


Figure 10. Simulated vs measured metereological data in the Chamizal station in El Paso for the WRF dataset; (a) wind direction and (b) wind speed.

In Figure 10, the coefficient of determination (R^2) for the Weather Research and Forecasting (WRF) model was the highest among the three datasets, with values of R^2 = 0.7 for both variables considered in the comparison.
Although WRF exhibited the strongest correlation, additional analysis is required—such as subdividing the study area into smaller regions—to better understand the relationship using the other datasets.

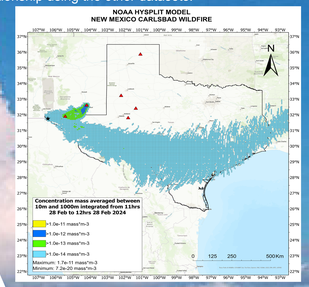


Figure 12. Dispersion concentration from a wildfire event in Calsbad, NM.

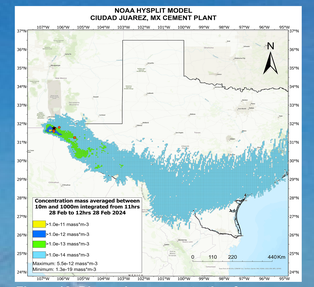


Figure 13. Dispersion concentration from an industry site in Ciudad Juarez, MX.

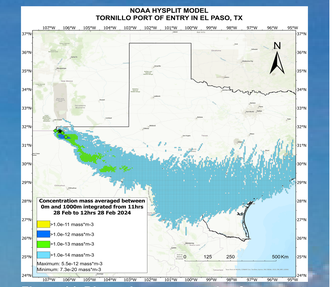


Figure 14. Dispersion concentration from a port of entry in Tornillo, El Paso, TX.

$PM_{2.5}$ less than 35μg/m³

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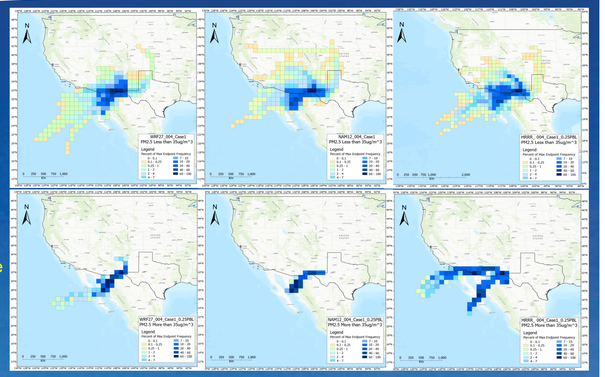


Figure 11. Back-trajectories at 0.25PBL using WRF27, NAM17 and HRRR.

Figure 11 present trajectory frequency maps or samples characterized by low and high concentrations of $PM_{2.5}$. Regions in blue denote the most frequent air mass trajectories, while regions in orange indicate less frequent trajectories over a 48-hour period, based on back-trajectory analysis to the Chamizal Station (CAMS 41) in El Paso, TX. For the event on February 28 2024, air mass trajectories corresponding to $PM_{2.5}$ concentrations exceeding 35μg/m³ predominantly originated from the southwest (SW) of El Paso. Additionally, trajectories associated with [$PM_{2.5}$] above 35μg/m³ also indicate air masses originating from the southwest (SW), northwest (NW), and northeast (NE) of El Paso. Figures 12, 13 and 14 show the the dispersion from a wildfire, a cement plant and a port of entry on Feb 28 at 11am passing through CAMS 41 Station in El Paso. The concentrations show unit/mass³ for maximum heights of 1000m. Figure 15 a and b show the Initial conditions over the boundary contidions for different emissions of anthropogenic secondary organic aerosol concentrations sources in El Paso, TX for February 28.

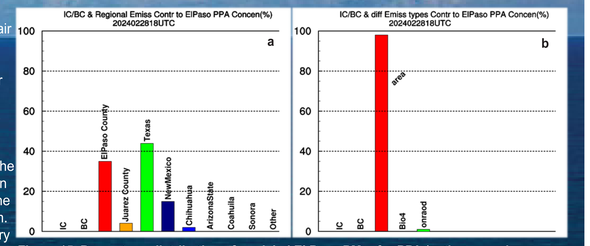


Figure 15. Percentage distribution of modeled El Paso $PM_{2.5}$ for PPA (anthropogenic secondary organic aerosol); (a) Boundary condition, initial condition, various emissions originated from different places, and (b) different type of emission.

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