

Southeast Los Angeles Health & Air Quality

An Assessment of Air Quality in Relation to Southeast Los Angeles Communities' Proximity to Interstate 710

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Abstract: This feasibility study utilized NASA Earth observations from Sentinel-5P TROPOMI and TEMPO instruments to assess air quality distributions related to heavy traffic congestion along Interstate-710 (I-710) in Southeast Los Angeles, California. This project partnered with Communities for a Better Environment, a non-profit organization advocating for a healthy and clean Los Angeles. Southeast Los Angeles communities located along the I-710 face significant air pollution burdens, exacerbated by high vehicle emissions and elevated levels of social vulnerability. In response, our team analyzed NASA satellite-derived data on air pollutants focusing on nitrogen dioxide and formaldehyde concentrations. Additionally, we developed a Social Vulnerability Index (SVI), incorporating factors such as population age, single-parent households, uninsured residents, multi-structure households, and individuals without vehicle access to identify neighborhoods most severely affected by poor air quality. Results showed a clear relationship between heavy traffic volume and elevated air pollution levels in vulnerable communities. Through this analysis, we demonstrated the feasibility of TEMPO as a valuable tool for visualizing localized environmental impacts, offering immediate benefits for public health advocacy and urban planning due to the sensor's frequent temporal resolution.

Key Terms: Air quality and health, Southeast Los Angeles, California, social vulnerability, nitrogen dioxide (NO₂), formaldehyde (HCHO), TEMPO, TROPOMI

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1. Introduction

1.1 Background Information and Scientific Basis

Interstate 710 (I-710) is a major interstate and transportation corridor connecting vital ports across California from Long Beach to Alhambra (Mandelkern, 2024). I-710 bisects a portion of Los Angeles County, including Southeast Los Angeles, which brings high traffic volume from motor vehicles and heavy-duty transportation vehicles (Anair et al., 2024; LA Metro, 2025). According to the California Department of Transportation, over 32,000 heavy-duty trucks (11.3% of traffic volume) per day, passed through the portion of the I-710 that goes through Southeast Los Angeles (Lovett et al., 2018; Houston, 2004).

Due to the high traffic volume, highway expansion measures have been proposed, but community engagement efforts halted these plans to prevent increased vehicle emissions from impacting local communities (LA Metro, 2025). Los Angeles has an excessive number of roads, highways, and bridges that are essential to accommodate its population and economic growth (LA Metro, 2025). Rapid urbanization also means higher impervious surface, more congested travel times and more emissions (Pfannerstill, E. Y. et al 2024). Vehicle tailpipe emissions are known to have downstream effects on respiratory health, particularly impacting those with asthma and chronic obstructive pulmonary disease (Meng et al., 2022). Despite improvements to air quality measures in California, vehicle tailpipes are known to emit harmful pollutants such as nitrogen dioxide (NO₂) and formaldehyde (HCHO) (United States Environmental Protection Agency [US EPA], 2025). Additionally, ozone (O₃) has been identified as a harmful respiratory pollutant (Zhao et al., 2025). While tailpipes do not emit O₃ directly, NO₂ and volatile organic compound emissions combine to create O₃ in the atmosphere (US EPA, 2024a). Residents of Southeast Los Angeles are especially at risk of experiencing these health issues due to their community's proximity to the interstate and the increased population density in that region, exposing a higher number of people to these pollutants (Gabbe, 2018).

To better understand the community concerns, our project investigated the potential vulnerability of the population close to I-710 by analyzing various social parameters. To do this, we leveraged data from the Tropospheric Emissions: Monitoring Pollution (TEMPO) Instrument, Sentinel-5P Tropospheric Monitoring Instrument (TROPOMI) to measure the key pollutants of this study, nitrogen dioxide (NO₂) and formaldehyde (HCHO), and ozone (O₃). In situ measurements from the Environmental Protection Agency (EPA) ground Sensors and Pandora air monitoring stations are also included to spatiotemporally validate observations from TEMPO and TROPOMI

1.2 Project Partners and Objectives

To assess how air pollution affects Southeast Los Angeles communities, our project partnered with Communities for a Better Environment (CBE). Founded in 1978, CBE is a non-profit organization that provides structured planning, leadership training, and legal, scientific, and technical assistance to the communities of Richmond, East Oakland, Wilmington, and Southeast Los Angeles (CBE, 2016). Their projects have engaged members in community advocacy work to promote clean air initiatives in Southeast Los Angeles. Los Angeles has historically been battling poor air quality since the mid-20th century as rapid urbanization and industrialization led to poor air quality (Cheung, K., 2012). For instance, CBE's 30-year-old campaign on I-710 successfully organized opposition to Caltrans' 710 expansion project (Linton, 2022). Additionally, CBE's research staff suggested examining highway performance monitoring system data and have addressed the importance of remote sensing analysis for their intergenerational community members to interpret and contribute to voicing the need for resilient infrastructure and parks.

To support these goals, CBE partnered with NASA DEVELOP to explore how NASA Earth observations can be used to explore the community impacts of highway air pollution. To do this, our team created two weekly trend timelapses to show how NO₂ and HCHO move throughout Los Angeles and investigate the pollutant concentration near I-710 and Southeast Los Angeles. Our team also investigated pollutant concentration in Southeast Los Angeles during peak traffic times. Additionally, the team created a social vulnerability index to identify key areas and communities that are most at risk of experiencing health issues

due to air pollution. Then we overlaid the social vulnerability index with a mean NO₂ concentration map from August in 2023 to explore overlaps between pollutant exposure.

1.3 Study Area and Period

The I-710 is established in the central part of Los Angeles Basin which is composed of many valleys, and mountains such as the San Gabriel Mountains North from the I-710 which can influence air quality and its dispersion, often causing secondary pollutants to become highly concentrated downwind from their source (Houston, 2004 & Chouza et al 2021). The I-710 corridor runs through different land use: 53% of corridor has residential districts, 34% are industrial districts, and 10% are commercial and service districts (LA Metro, 2022). This project evaluated data from August 2023 to December 2024 within a portion of Los Angeles' Subregional boundaries intersecting I-710 (Figure 1). Our research period began in August 2023, when TEMPO was released to the public. Our research end date was December 2024 to align with the project's start date. The boundaries were chosen to account for freeways that feed into I-710, such as State Route 1 (SR-1), SR-91, SR-60, I-405, I-105, 1-5, and I-10. This larger regional analysis allowed for comparisons between the Southeast Los Angeles region and I-710, as well as surrounding freeways and areas, to provide further insight into air quality distribution and distinguish other potential sources of pollution.



Figure 1. Study area consist of the Southern LA Subregional Boundaries; South Bay, Gateway Cities, Arroyo Verdugo, Central Los Angeles, and San Gabriel Valley. While Highlighting Southeast Los Angeles in the yellow polygon and the I-710 Highway, which has a 4.5-mile gap. [Basemap: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community]

2. Methodology

2.1 Data Acquisition

2.1.1 TEMPO

The TEMPO instrument (Tropospheric Emissions: Monitoring of Pollution) monitors atmospheric trace gases impacting air quality over North America hourly from geostationary orbit. The data first became available to use in August 2023. It measures ozone, nitrogen dioxide, and formaldehyde, and provides cloud fraction and cloud pressure with the addition of many other gas products (NASA 2025c). Our team acquired Level 3 (L3) NO₂ and HCHO TEMPO data from the ArcGIS Pro Living Atlas Portal as a multidimensional raster layer from ESRI Living Atlas Portal (NASA ArcGIS Online) with a pixel size of 2 km x 2 km. L3 O₃ measurements were unable to be used for spatial analysis since the data was not available on the Living Atlas Portal until after the completion of the project term, however, Level 2 (L2) O₃ measurements were used for the time series assessments.

2.1.2 TROPOMI

The Tropospheric Monitoring Instrument (TROPOMI) was co-funded by the ESA (European Space Agency) and the Netherlands. Data from TROPOMI was first available to use in July 2018. It is a space-borne, nadir-viewing imaging spectrometer to obtain data in wavelength bands from ultraviolet to shortwave infrared (NASA 2025b). The instrument operates in a push-broom configuration and has a swath width of 2,600 km with a pixel size of 7.0 km x 3.5 km. (NASA 2025b). We acquired monthly mean NO₂ data from TROPOMI from NASA EarthData as a NetCDF File and imported the data into ArcGIS as a raster imagery layer to use for our principal component analysis (PCA). Due to technical challenges in integrating TROPOMI and TEMPO datasets into our PCA, we only used one month of NO₂ data from August 2023. This limitation was largely due to time constraints; however, this preliminary analysis still provided valuable guidance for our partners, helping inform future exploration of more specific time periods relevant to their needs.

Table 1.

List of monitors, sensors, and data products used in this project.

Sensor	Parameter	Dataset (citation)	Dates	Source
TEMPO	NO ₂ tropospheric vertical column	TEMPO gridded NO ₂ Vertical Column Troposphere V03 Level 3 (provisional) (ESRI)	August 2023 - December 2024	ESRI Living Atlas Portal (NASA ArcGIS Online)
	HCHO vertical column	TEMPO gridded HCHO vertical column V03 Level 3 (provisional) (ESRI)	August 2023 - December 2024	ESRI Living Atlas Portal (NASA ArcGIS Online)
Sentinel-5P TROPOMI	NO ₂ tropospheric vertical column	Sentinel-5P TROPOMI NO ₂ GLOBAL Monthly Level 3 5 x 5 km Gridded Data Version 2.4. (ESRI)	August 01, 2023 - August 31, 2023	NASA EarthData
Pandora	NO ₂ , HCHO, and O ₃ tropospheric vertical column	Reference measure of atmospheric levels of NO ₂ , HCHO, and O ₃ . (Pandora n.d).	August 02, 2023 - August 31, 2023	Pandonia Global Network
EPA	NO ₂ 1-hour data maximum and O ₃ 8-hour maximum data	Tables of daily maximum data of NO ₂ and O ₃ . (US EPA n.d.).	August 01, 2023 - December 31, 2024	AirNow

2.1.2 Ancillary Data

Air quality ground monitoring stations and sensors were used to assess the quality of the NO₂, HCHO and O₃ data sourced from TEMPO. These stations utilize similar data collection techniques (NASA 2025a) by using a direct light source, the sun, to collect hourly data in the lower parts of the atmosphere. Additionally, the Centers for Disease Control (CDC) data were used to create social vulnerability index maps.

Pandora sensors gather data from several aerosols and pollutants, including O₃, HCHO, and NO₂ from its ground-based multi-axis differential optical spectrometer (NASA 2016). To ensure the on-ground monitors aligned with the data retrievals from TEMPO, our team utilized the Whittier, CA ground sensor station (Table 2), the nearest station to Southeast Los Angeles, to compare with the data from TEMPO. Our team accessed the data from the NASA Atmospheric Science Data Center (ASDC) GitHub through a Python notebook (Kaufman et al., 2025). Due to personal computer storage capabilities, our team was unable to examine Pandora data past the month of August 2023. Additionally, the Environmental Protection Agency (EPA) hosts ground-based air quality monitors through AirNow for the pollutants NO₂ and O₃. Our study utilized Air Quality System (AQS) sensors located in Compton, CA to further assess TEMPO data. We chose this sensor due to its proximity to our immediate Southeast Los Angeles study area. Pandora measurements are comparable to satellite measurements as they both provide vertical column aggregated measurements, but the EPA sensors only provide measurements near the surface.

Table 2.
Coordinates of Pandora and EPA's ground sensors

Senor	Site	Latitude, degree	Longitude, degree
Pandora	Whittier, CA	33.9768	-118.029
Air Quality System	Compton, CA	33.9013	-118.2059

2.1.3 Sociodemographic Data

Our team collected health data from the Centers for Disease Control and Prevention's (CDC) Agency for Toxic Substances and Disease Registry's (ATSDR) Social Vulnerability Index (2024), using 2018-2022 estimates for six indicators: populations aged 17 and younger, populations aged 65 and older, single-parent households, multi-unit structures, lack of health insurance, and no vehicle access. We applied the PCA to these variables, identified those with the highest social vulnerability scores, and created a social vulnerability index to produce a social-environmental bivariate map.

2.2 Data Processing

2.2.1 Processing Data for Weekly Trend Timelapse

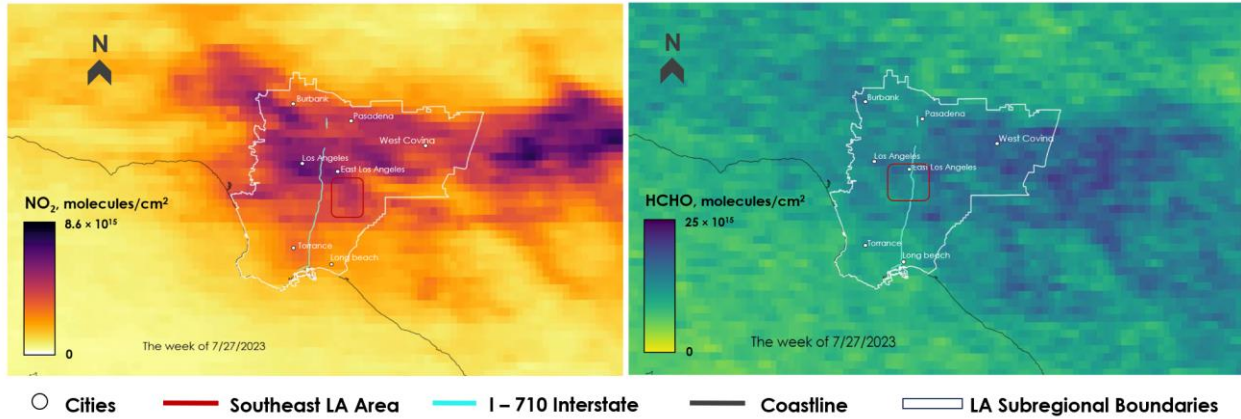


Figure 2. Maps of averaged nitrogen dioxide and formaldehyde concentrations in Los Angeles during the week of July 27, 2023.

Additionally, our team created a monthly timeseries plot to accompany the weekly trends video. To do this, we used the *Temporal Profile* tool under the *Multidimensional* tab from ArcGIS 3.40 to generate a timeseries graph of each pollutant. Then, the data tables were extracted as csv files and uploaded into R Studio. In RStudio, the time series graphs were plotted using the packages *tidyverse*, *janitor*, *lubridate*, *ggplot2*. We converted the column, “StdTime” into a “Date Time” object. The months and years were extracted from StdTime and were created into their own columns titles “Months” and “Years”. These columns were then aggregated by the pollutant measurements to obtain the monthly means. Finally, NO₂ and HCHO were plotted alongside each other in one graph (Figure 3).

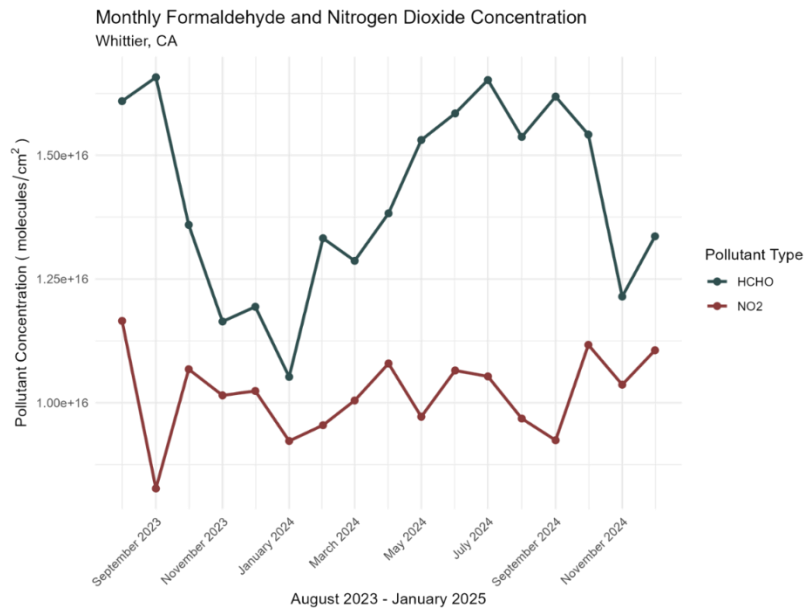


Figure 3. A time series comparing TEMPO monthly means for formaldehyde and nitrogen dioxide concentrations in Whittier, CA, from August 2023 to December 2024.

2.2.2 Processing Data for Social Vulnerability Index Map and Bivariate Map

We used the PCA to assess the SVI and reduce a large dataset of variables into a smaller set based on variance, identifying the most influential indicators for a composite score. We collected data from the CDC ATSDR's Social Vulnerability Index (SVI) (2024), using 2018-2022 estimates for six indicators: populations aged 17 and younger, populations aged 65 and older, single-parent households, multi-unit structures, lack of health insurance, and no vehicle access. We filtered this data at the Census Tract-level for Los Angeles County and downloaded it as a CSV file for analysis in RStudio for the PCA. Additionally, we standardized sociodemographic indicators within the PCA script in RStudio, extracting two specific vulnerability indicators with the highest variances. Our team calculated the PCA to have quantile breakpoints at 0%, 33.3%, 66.7%, and 100% to divide the data into three roughly equal groups, creating a function to categorize each data point into quantiles 2 through 6. We then merged the CDC ATSDR's SVI dataset with air quality data using a common geographic identifier, spatially aligning all variables for visualization using the *Raster Extraction* and *Zonal statistics* tools in QGIS. Missing values from the raster image collected from TROPOMI's NO₂ monthly mean for August 2023 were addressed in these tools by assigning a value of -9999 to the output bands, facilitating spatial visualization of these data gaps. The scores, initially measured in quantiles 2-6 on QGIS, were converted into rankings ranging from very low to very high for classification clarification.

2.2.3 Processing Data for Congestion Maps

Our team followed similar steps to complete the processing for the congestion maps as we did with the weekly trend timelapse. First, we identified peak traffic times along I-710 sourced from traffic data from CALTRANS Traffic Census 2022 Peak Hour Volume Data (Caltrans, n.d). This dataset contains AM and PM peak traffic periods for a single day within a month. Since TEMPO did not have early-morning data available, we chose to use the evening peak times. I-710 had two peak traffic times: Tuesdays in January at 3:00 PM and Tuesdays in April at 5:00 PM. We investigated peak traffic on Tuesday January 9th, 2024, at 3:00 PM for NO₂ and HCHO due to a lack of data availability in April for HCHO.

2.3. Data Analysis

2.3.1 Social Vulnerability and Air Quality Map

The PCA revealed the highest variances among indicators included populations aged 17 years and younger, accounting for 34.6% of the explained variance, and single-parent households, which accounted for 27.5%. We combined these two indicators with air quality data using the *zonal statistics* tool in QGIS to calculate TROPOMI's NO₂ monthly mean for August 2023 alongside the social vulnerability index scores. These outputs ultimately supported the visualization of a bivariate map using a *bivariate symbology* directly from QGIS rather than in the PCA. Thus, across the entire study area of Southeast Los Angeles, we identified the maximum NO₂ monthly mean for August 2023 as 8.50×10^{15} molecules/cm² with very high social vulnerability. Furthermore, the minimum NO₂ value was 2.02×10^{15} molecules/cm² with very low social vulnerability, particularly in the Southern region of Southeast Los Angeles. Within the specific study site defined by the community partners, we found the maximum NO₂ monthly mean, also 8.50×10^{15} molecules/cm² with very high social vulnerability. The minimum value was 4.94×10^{15} molecules/cm² with very low social vulnerability. Our team excluded TROPOMI from the PCA analysis because it was calculated through a *zonal statistic* in QGIS 3.42.0, which produced a raster dataset in combination with a vector shapefile.

2.3.2 Peak Traffic Counts for NO₂ and HCHO

After peak traffic times were identified, we used the *Configure Extent* tool in ArcGIS Pro and set the start date to 01/09/2024 at 14:15:44 and our end date to 01/09/2024 at 16:15:44 to find the maximum NO₂ and HCHO concentrations within a 3-hour window of the identified peak traffic time which was the time within this window that had the maximum concentration of each pollutant. In the *Aggregation* tab, the *Time Aggregation* and *Spatial Aggregation* were set to "Maximum", and the *Interval Step* was set to "Hours". Additionally, *Build Pyramids* was selected to improve the quality of the output. The aggregation steps resulted in a recalculation of the maximum and minimum pollutant values. For NO₂, the maximum value became 3.3

$\times 10^{16}$ molecules/cm² and the minimum value became 1.1×10^{16} molecules/cm². For HCHO, the maximum value became 2.1×10^{16} molecules/cm² and the minimum value became -2.8×10^{16} molecules/cm². Negative NO₂ and HCHO concentrations are normal and expected due to retrieval uncertainties (Rijsdijk et al., 2025).

3. Results

3.1 Analysis of Results

3.1.1 Social Vulnerability Index

The principal component analysis of the SVI identified populations aged 17 years and younger and single-parent households as the most influential indicators. The resulting social vulnerability map illustrated the spatial distribution of communities most at risk from environmental and health-related impacts. The map showed a notable concentration of highly vulnerable communities seen in dark purple along the eastern side of Los Angeles, particularly east of the I-710. In contrast, areas toward the northwest of the region exhibited lower levels of vulnerability (Figure 4).

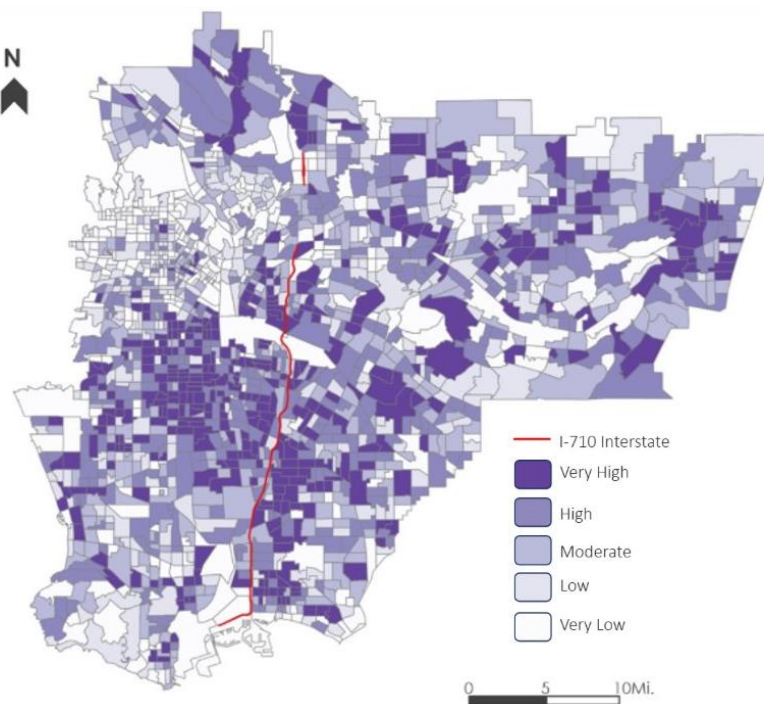


Figure 4. Principal component analysis of the social vulnerability indexes, from CDC ATSDR 2018-2022. Estimates based on 6 social vulnerability variables: age 17 & younger, age 65 & older, single parent households, multi-unit structures, no vehicles, and no health insurance.

3.1.2 Social Vulnerability and Air Quality Bivariate Map

Analysis of Sentinel-5P TROPOMI data from August 2023 indicated notably higher NO₂ concentration scores in northern areas of Southeast Los Angeles compared to southern regions. Our team further analyzed 11 census tracts intersecting with the I-710 corridor and identified five tracts classified as high-exposure areas for NO₂ pollution. 5 of the 11 Census Tracts most vulnerable were: Bell, Commerce, Cudahy, Lynwood, and South Gate (Figure 4). The highest levels of NO₂ and social vulnerability combined were located at Census Tract 204920, between the City of Vernon and Commerce. Additionally, the lowest values of NO₂ and social vulnerability were located at Census Tract 670416 in the Southern region of Southeast Los Angeles, particularly in Rancho Palos Verdes. Within the specific study site defined by the community partners, we found the maximum NO₂ monthly mean with very high social vulnerability at Census Tract 204920, located

in the City of Commerce. The lowest value of NO₂ with very low social vulnerability at Census Tract 542103, located in the City of Lynwood.

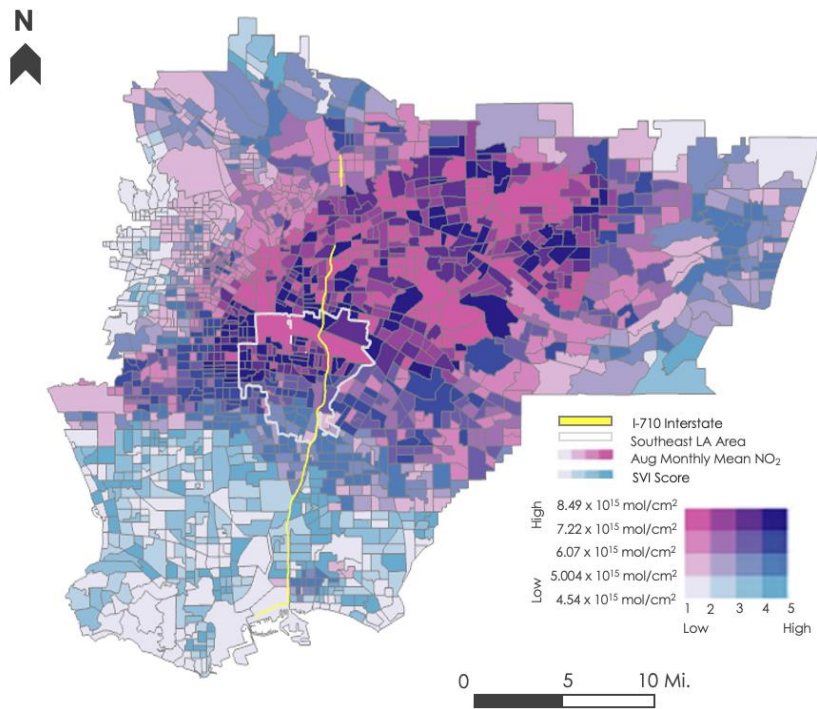


Figure 4. Social vulnerability and air quality bivariate map, computed from the PCA with social vulnerability variables age 17 years and younger and single parent households combined with TROPOMI’s NO₂ for monthly mean of August 2023 because of summer peak traffic times. Referring to the legend areas, white color areas represent low NO₂ concentrations and a low social vulnerability, bright pink indicates high NO₂, bright blue represents high social vulnerability, and dark purple shows areas with both. Dark purple regions indicate communities most vulnerable to pollution-related health risks and we can see Southeast Los Angeles showed notably high NO₂ and high social vulnerability, compared to the south portion of Southeast Los Angeles which had lower NO₂ concentrations and social vulnerability.

3.1.3 Peak Traffic Counts for NO₂ and HCHO

Analysis of TEMPO NO₂ and HCHO data on January 9th from 14:15:44 to 16:15:44 shows that NO₂ concentrations in the neighborhoods of Vernon, Commerce, Maywood, Huntington Park, Bell, and Bell Gardens, and around the I-710 have high concentrations within this 3-hour window (Figure 5a). HCHO concentrations remain relatively low and do not have notably high concentrations within Southeast Los Angeles or around I-710 (Figure 5b).

3.2 Errors & Uncertainties

An overall limitation we experienced in this study was the presence of gaps in our Earth observational data due to cloud coverage. Clouds reflect a substantial amount of light from both the Earth’s surface and the atmosphere, which can create gaps in the data. A very cloudy day can significantly compromise the overall time frame aggregations we conducted.

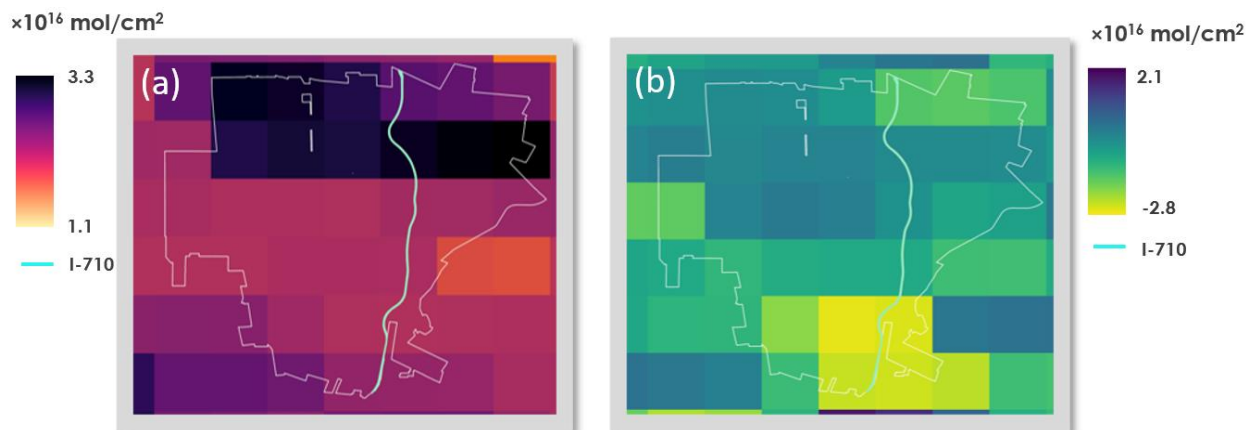


Figure 5. Map of NO₂ and HCHO concentration during the traffic peak on Tuesday, January 9 (14:15:44 - 16:15:44) in Southeast Los Angeles. The NO₂ and HCHO concentration were aggregated for a 3-hour window of time.

3.2.1 Validating TEMPO with Pandora Ground Sensors

Our team compared data of Level 2NO₂, O₃, and HCHO from TEMPO with those measured by a Pandora ground sensor located at Whittier College in California. We chose the Whittier location due to its proximity to our study site. It is important to note that TEMPO and Pandora ground monitors collect and process the data differently. To account for that, our team smoothed the Pandora data during the pre-processing for comparison, and it was interpolated onto TEMPO observation times. While a comprehensive validation study was not conducted, we performed an initial comparison between TEMPO-derived air quality parameters and compared with in-situ sensor data. This comparison aimed to demonstrate the usability of satellite-derived air quality parameters to stakeholders. For comprehensive information on the validation process of TEMPO data, visit NASA teams at the Short-term Prediction Research and Transition (SPoRT) center (NASA, n.d.) and refer to the publications created by the TEMPO validation teams (NASA, 2025f; Henderson et al. 2024).

The Python notebooks found in the TEMPO/L2_validation_codes folder in the ASDC GitHub repository (Kaufman et al., 2025) describes a more in-depth process for validation of TEMPO air quality products. Following the steps found in these notebooks, the team retrieved data from Pandora and TEMPO through EarthAccess and plotted the comparison between the two data sources. First, in-situ monitoring data was accessed from the Pandora station at Whittier, CA from August 1st, 2023 – August 31st, 2023 at the beginning of our study period. Then, TEMPO data files that contained the latitude and longitude of the Whittier, CA station were retrieved for that time period and compiled into two separate time series products: one containing both positive and negative pollutant values and another containing positive pollutant values only. Next, a Pandora time series was created and both time series retrievals were made into time series and linear regression plots. The time series of NO₂ and HCHO from August 2nd to August 31st are shown in Figure 7 and 8.

The O₃ data was assessed in the same manner, (Figure 8) however, slight changes to the process were made as the original assessment was conducted with the Deep Space Climate Observatory (DSCOVR) satellite which was not being used in this project. The changes made to the code only consisted of commenting out lines of code for DSCOVR retrievals and plotting. While our team was unable to spatially visualize TEMPO O₃ data, we determined it was important to include this information to provide our partners with additional information on an additional vehicle-tailpipe pollutant to support their exploration of the data. The time series of O₃ is shown in Figure 9. The three time series (Figures 7, 8 and 9) suggested a positive correlation between the in-situ measurement and the TEMPO measurement.

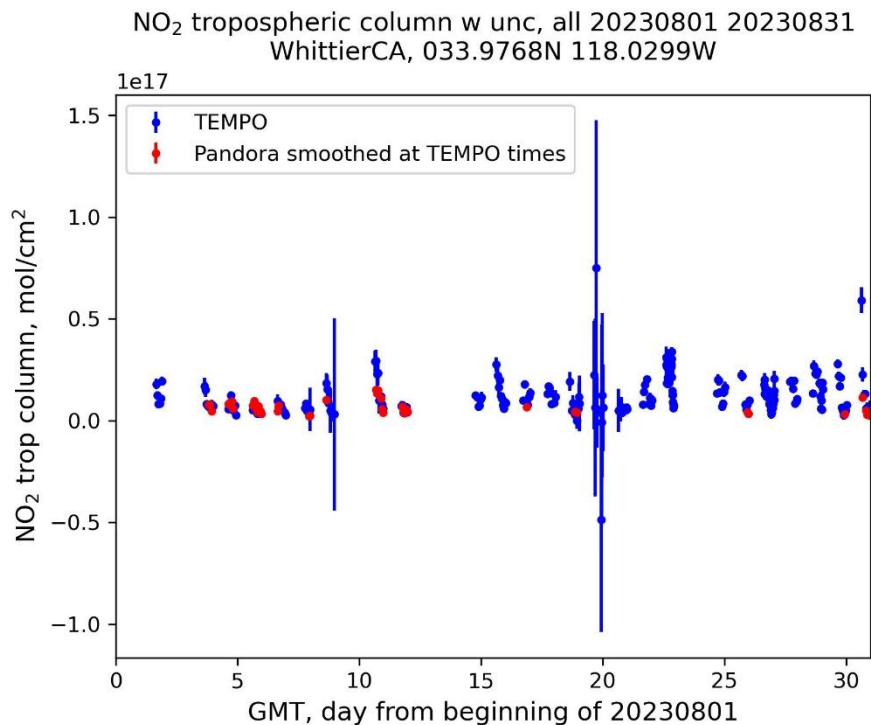


Figure 6. NO₂ concentration time series with error bars from August 2nd to August 31st at Whittier, CA.

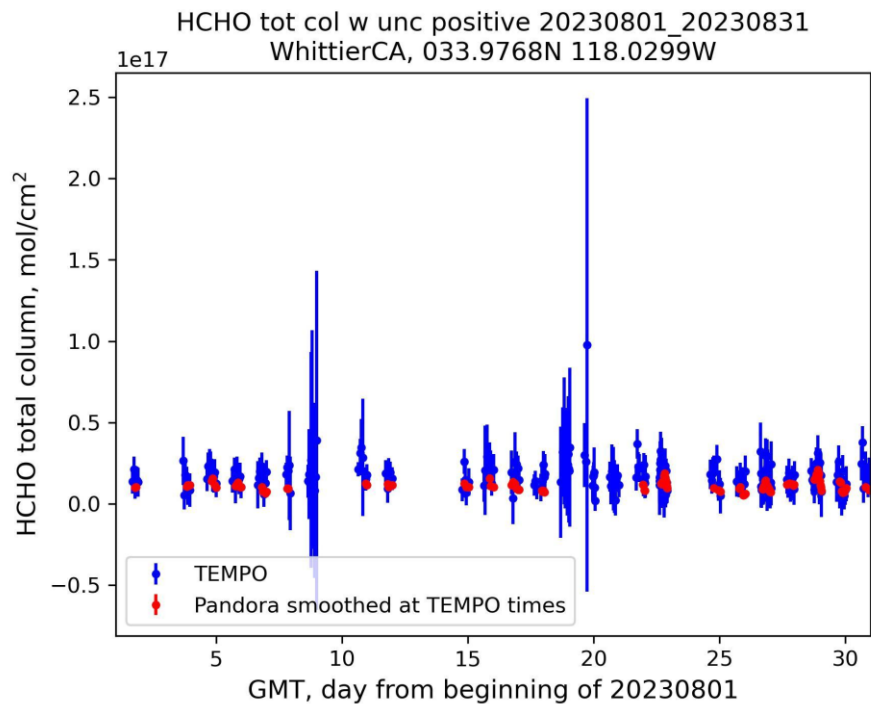


Figure 7. HCHO concentration time series with error bars from August 2nd to August 31st at Whittier, CA.

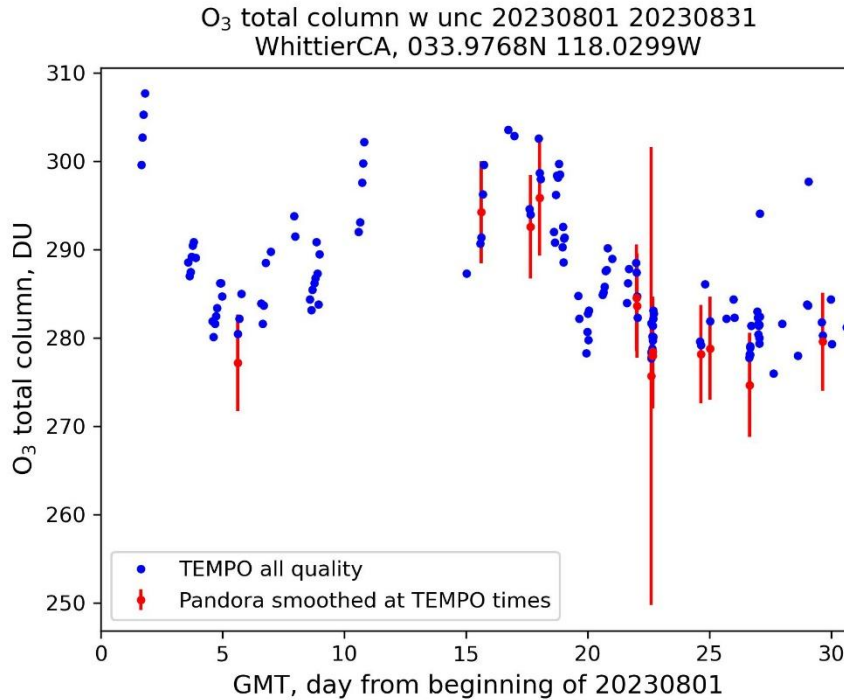


Figure 8. O₃ concentration time series with error bars from August 2nd to August 31st at Whittier, CA.

3.2.2 NO₂ Time Series for TEMPO and EPA Ground Sensor

To draw a direct comparison between the NO₂ data collected from TEMPO and the NO₂ data collected from the EPA sensor in Compton, we created a time series plot displaying both data sets. Our team created a time series through RStudio using the packages *tidyverse*, *janitor*, *lubridate*, *ggplot2*, and *scales*. First, the date column from the EPA ground sensor data table and the *StdTime* column from the TEMPO data table were converted to “Date^Time” objects. Then, the team aggregated the TEMPO data table by daily means. Next, the team scaled the data manually to account for the unit difference. Creating this scale was necessary to display the time series of both data sets since TEMPO NO₂ data is measured in molecules/cm² and the ground sensor NO₂ data is measured in parts per billion (ppb). These units are unable to be converted to a similar unit of measurement without additional variables that our team was not able to gather. Once this step was complete, our team graphed each dataset on the same plot as shown in Figure 10. While the data is not 1-to-1 since the ground-based sensors only measure surface air quality, this was still a valuable comparison to examine. Through this comparison, the team concluded that the ground sensor data displays comparable measurements to the satellite data. It is important to note that EPA data sourced through AirNow data are not fully validated or verified and cannot be used to draw formal conclusions about the results of the data. However, for the purposes of this study, the data was used exclusively to visualize trends and potential patterns (EPA, n.d).

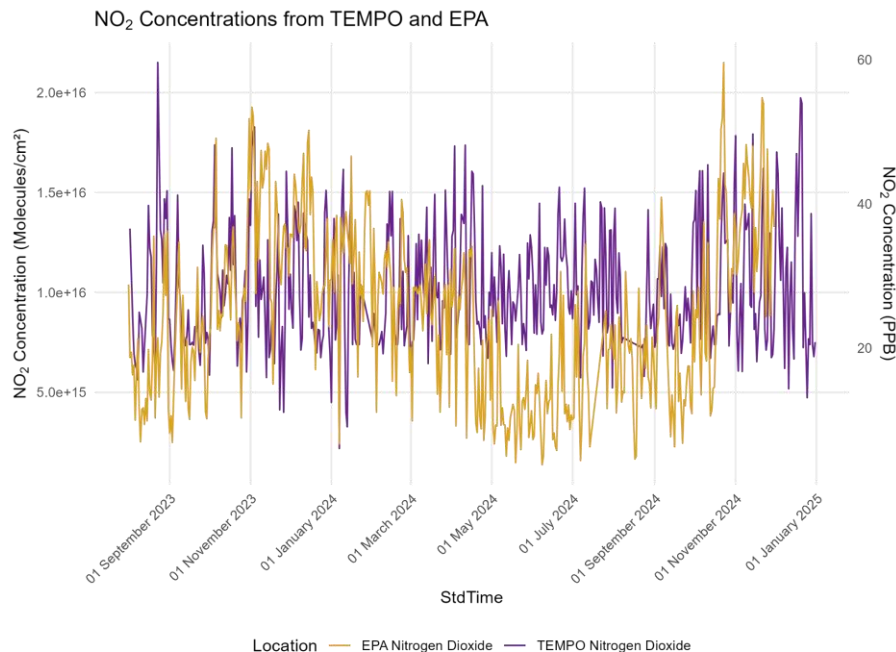


Figure 9. Daily average NO₂ from TEMPO and daily maximum NO₂ from an EPA ground sensor in Compton, CA from August 01, 2023, to December 31, 2024.

4. Conclusions

4.1 Interpretation of Results

Based on our results, we concluded that TEMPO is a valuable tool to study HCHO and NO₂ concentrations at spatial and temporal scales useful for studying city and county-level areas over a long period of time. We identified high pollutant areas within Southeast Los Angeles and analyzed HCHO and NO₂ trends from August 2023 to December 2024. High HCHO concentrations were reported in September 2023 and 2024, displaying possible seasonal trends. Spatially, HCHO was evenly distributed around Southeast Los Angeles, displaying no significant concentration in particular areas.

This may occur because HCHO is an organic compound primarily emitted from natural sources which often change with the season. High HCHO concentrations may result from biogenic volatile organic compounds (BVOCs) released by plants when under stress due to the lack of water or high temperatures during Summer (Chauhan et al 2025).

NO₂ concentrations typically follow a seasonal trend, with higher levels observed during winter months due to a combination of increased emissions from combustion sources and reduced photochemical breakdown in shorter daylight conditions. It is important to note that NO₂ is a great indicator of vehicle combustion, as its lifetime is very short, and often remains where it was emitted. Reduced sunlight during the winter season creates a long lifespan for NO₂ during December, January and February (Boersma et al, n.d). Despite these general trends of NO₂ exceeding during the winter, our study showed a lower monthly mean for NO₂ in Southeast Los Angeles. In our team's investigation of traffic times, we found that NO₂ had higher concentrations during peak hours and HCHO had relatively lower concentrations during peak hours. Partners will use this information to identify times of peak poor air quality. This will allow them to ensure that local air quality regulations are being followed, and it will ensure that our partner's community concerns are being addressed.

We are confident that CBE can use TEMPO and TROPOMI data to advance future air monitoring projects. By integrating NASA Earth observations in addition to ground-based sensors, CBE can assess air quality on a finer scale while also identifying communities that need more resources. We are confident that CBE can incorporate these methodologies alongside their existing approaches to further develop and explore other new initiatives.

4.2 Feasibility & Partner Implementation

Our team concluded that it is feasible to use TEMPO and TROPOMI data to understand and address air pollution trends. TEMPO offers high temporal resolution and hourly monitoring capabilities, which can be used to estimate NO₂ and HCHO patterns more accurately in Southeast Los Angeles allowing the end user to explore specific times for their benefit. We identified a strong correlation between TEMPO NO₂ and the EPA Ground Sensor NO₂ data. However, between May 2024 through July 2024 the EPA sensor represented lower NO₂ concentrations compared to TEMPO NO₂ concentrations. Additionally, TROPOMI data was used along social vulnerability indicators to identify high-risk communities with poor air quality. Due to time limitations and technical issues, we recommend that our partners conduct the PCA analysis over a more specific time interval rather than relying on a one-month snapshot, as done in our project. Additionally, due to time limitations, we recommend that our partners compare peak traffic times in Southeast Los Angeles to non-peak traffic times and graph a time series plot over the entire day of January 9th, 2024. Analyzing longer periods, such as a full year, will allow them to identify trends and determine which areas require more resources. The versatility and usability of satellite data can enable the partners to further explore different trends with other pollutants of interest, making these satellite sensors a powerful tool to monitor air quality trends.

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6. Glossary

ArcGIS Pro – A geospatial analysis platform developed by ESRI where users can analyze satellite imagery and create maps

CBE – Acronym for Communities for a Better Environments

Earth Observations – Satellites that collect information about Earth physical, chemical and biological system over space and time

HCHO – Chemical symbol for Formaldehyde

NO₂ – Chemical symbol for Nitrogen Dioxide

TEMPO – NASA’s Tropospheric Emissions: Monitoring of Pollution, a satellite spectrometer measuring air quality hourly over the Northern Hemisphere.

TROPOMI – European Space agency Tropospheric Monitoring instrument, satellite spectrometer measuring air quality at a low Earth orbit

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