



# Low-Cost Air Sensor Study in the Paso del Norte

Mayra Chavez, Adrian Vazquez Galvez, Yazmín Hernández  
García, Frida Toquinto Manjarrez, Wen-Whai Li

PRESENTED TO THE JAC ON FEBRUARY 11, 2021

# Research Objectives

## Goals:

- Improve air quality monitoring in the border region;
- Produce a case study of scientific measurement and analysis of air quality using low-cost air sensors;
- Foster binational technical exchange between government agencies and research institutions in the Paso del Norte.

## Objectives:

- Provide real-time spatial and temporal concentration patterns of PM to the public.
- Assess air quality and emissions associated with transportation by developing an algorithm to predict air pollution for near-road receptors using land-use regression technique.

- The project will install an air monitoring network in the PdN to measure  $PM_{2.5}$ , at up to 31 sites in the El Paso and Ciudad Juarez (Cd. Juarez).
- The sampling project time is expected to be 2 months.
- The 15-month project will be a collaborative effort among the researchers at the University of Texas at El Paso (UTEP) and Universidad Autonoma de Ciudad Juarez (UACJ).





# Task 1 Elementary Schools

- Task 1 involves monitoring PM levels at selected public elementary schools in the PdN.
- 17 elementary schools of high and low traffic exposure based on AADT.
- 12 sites in El Paso and 5 sites in Cd. Juarez.
- UACJ will assist with monitors placed at 5 sites in Cd. Juarez near targeted elementary schools.



# Task 1 Monitoring Network

- The El Paso Independent School District (EPISD) has been working closely with UTEP team to install Purple Air Sensors at their schools.
- EPISD contributions have included:
  - Installing outdoor outlets for sensors at each school.
  - Ensuring stable Wi-Fi connections at each school for sensors.
  - Installing all 12 Purple Air sensors at elementary schools in El Paso, including duplicate sensors for quality control.
  - Registering each sensor location online.

# Task 2 Sitios Industriales

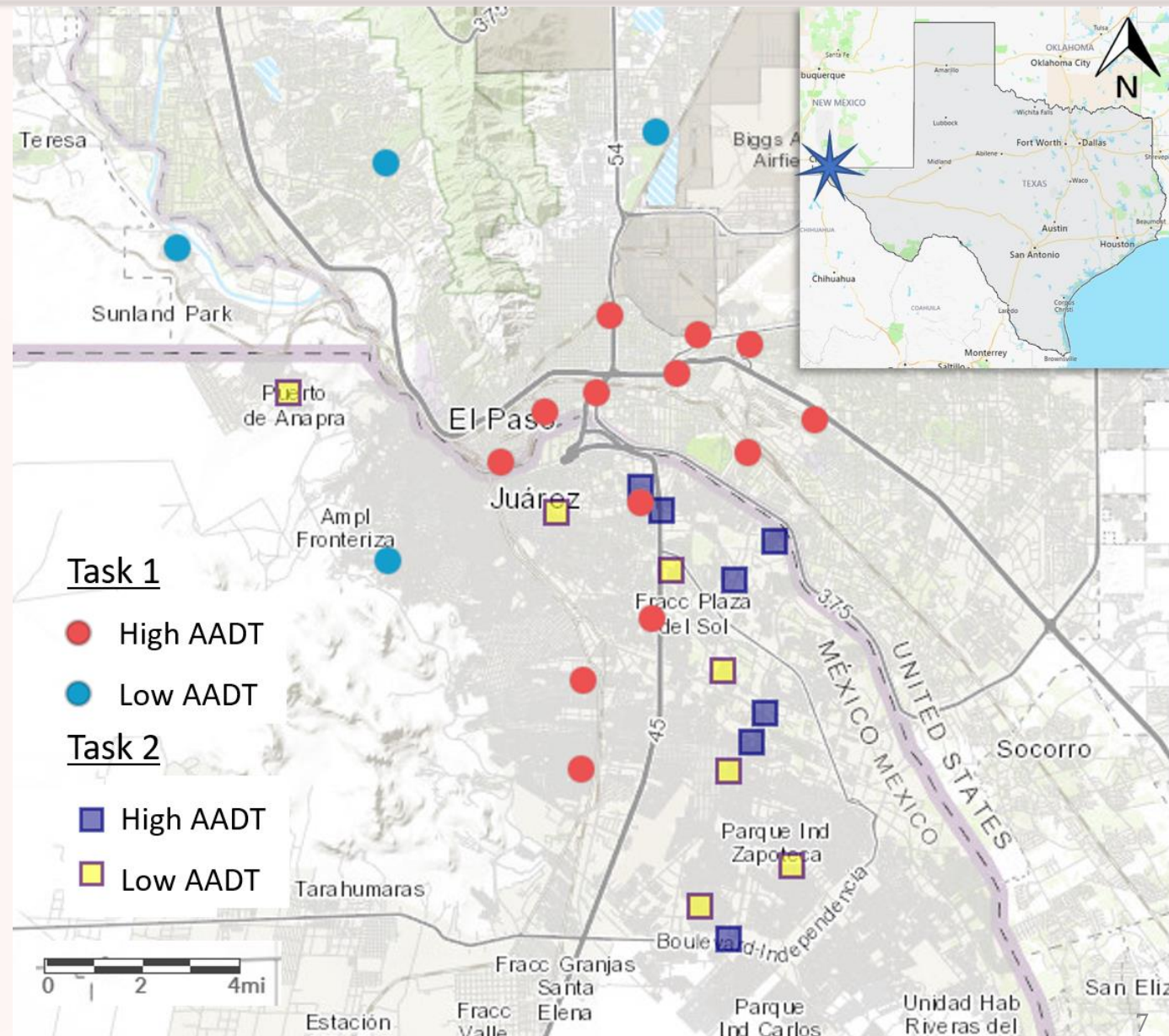
- La Tarea 2 involucra el monitoreo de MP en el sector industrial de Ciudad Juárez.
  - Se elegirán 14 sitios de monitoreo en zonas industriales de Ciudad Juárez de acuerdo con las necesidades del proyecto y también se ubicarán en áreas de baja y alta tráfico vehicular.
  - Debido a las restricciones de COVID-19, los sitios pueden ubicarse en residencias cerca de sitios industriales específicos.
- 
- Task 2 involves monitoring PM in the industrial sector in Ciudad Juarez.
  - 14 monitoring sites in industrial zones in Ciudad Juarez will be chosen according to the needs of the project and will also be placed in low and high traffic exposure areas.
  - Due to COVID-19 restrictions, sites may be placed at residences near targeted industrial sites.

## Task 1

- Elementary Schools
- 17 total sites in El Paso and Ciudad Juarez

## Task 2

- Industrial Sites
- 14 total sites



- All sensors will be first compared in the field against TCEQ's FRM-approved PM<sub>2.5</sub> monitor.
- 48 sensors were placed immediately adjacent to TCEQ's CAMS 12 site.



CAMS 12 Site Location.



# Calibration Set-up



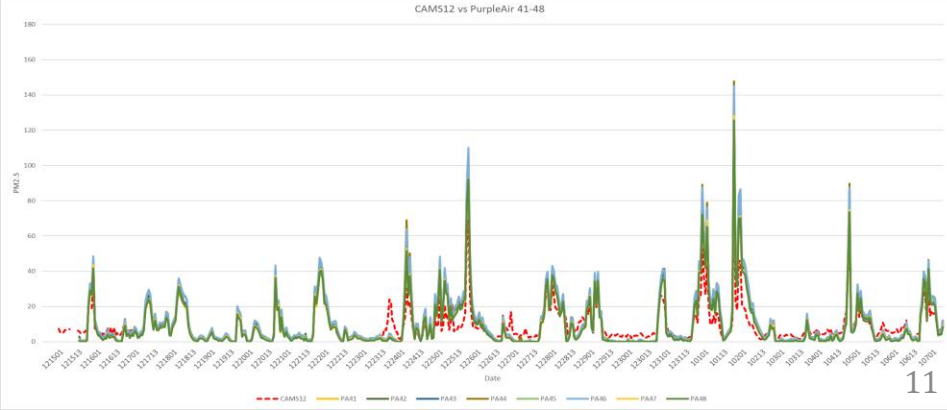
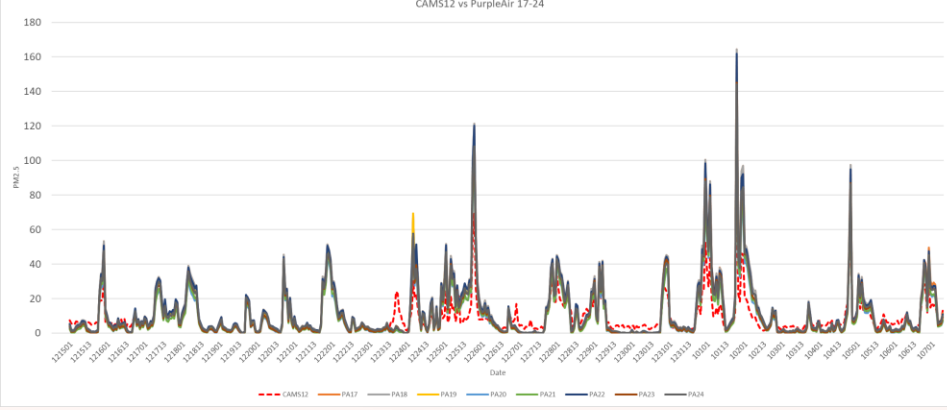
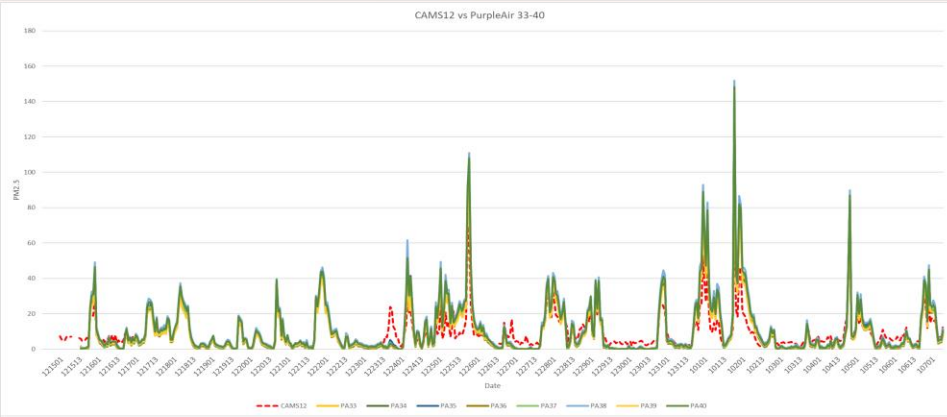
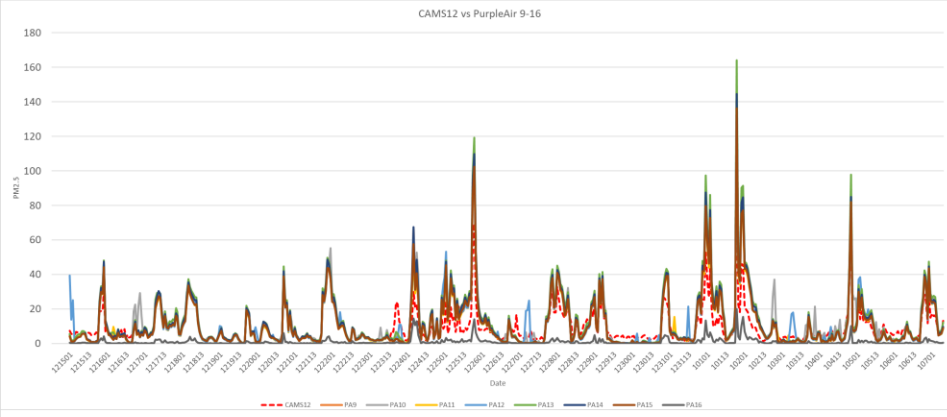
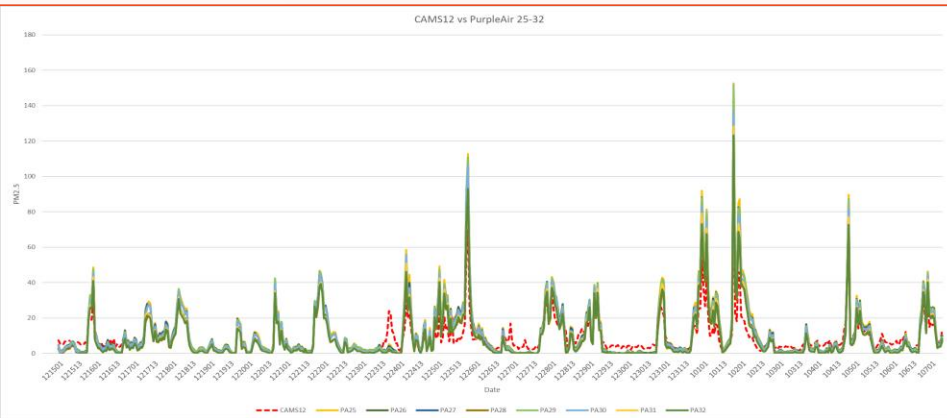
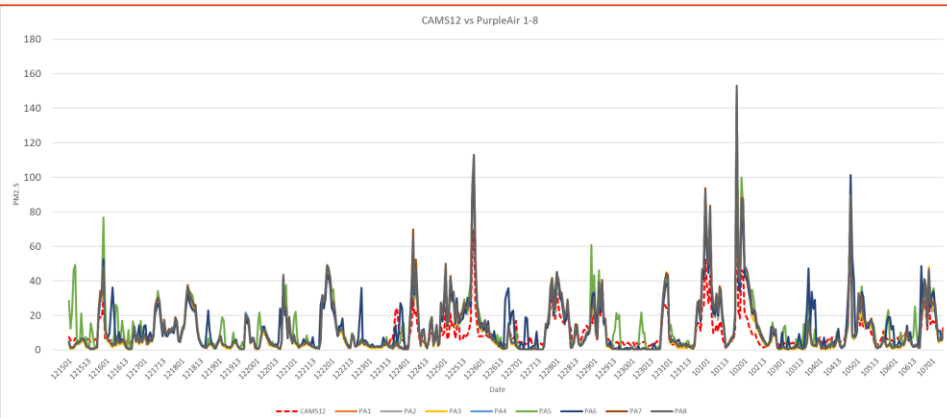


# Pre-Calibration Data

- Time Series of 48 sensors during 12/21-1/6 calibration
  - Split between 1-24 and 25-48
- Correlation Plots between Purple Air (PA) sensors and TCEQ station (CAMS12).
  - $R^2$  values all approximately 0.8
- Post-Calibration will take place after the field study ends and will include the same set-up and data processing.

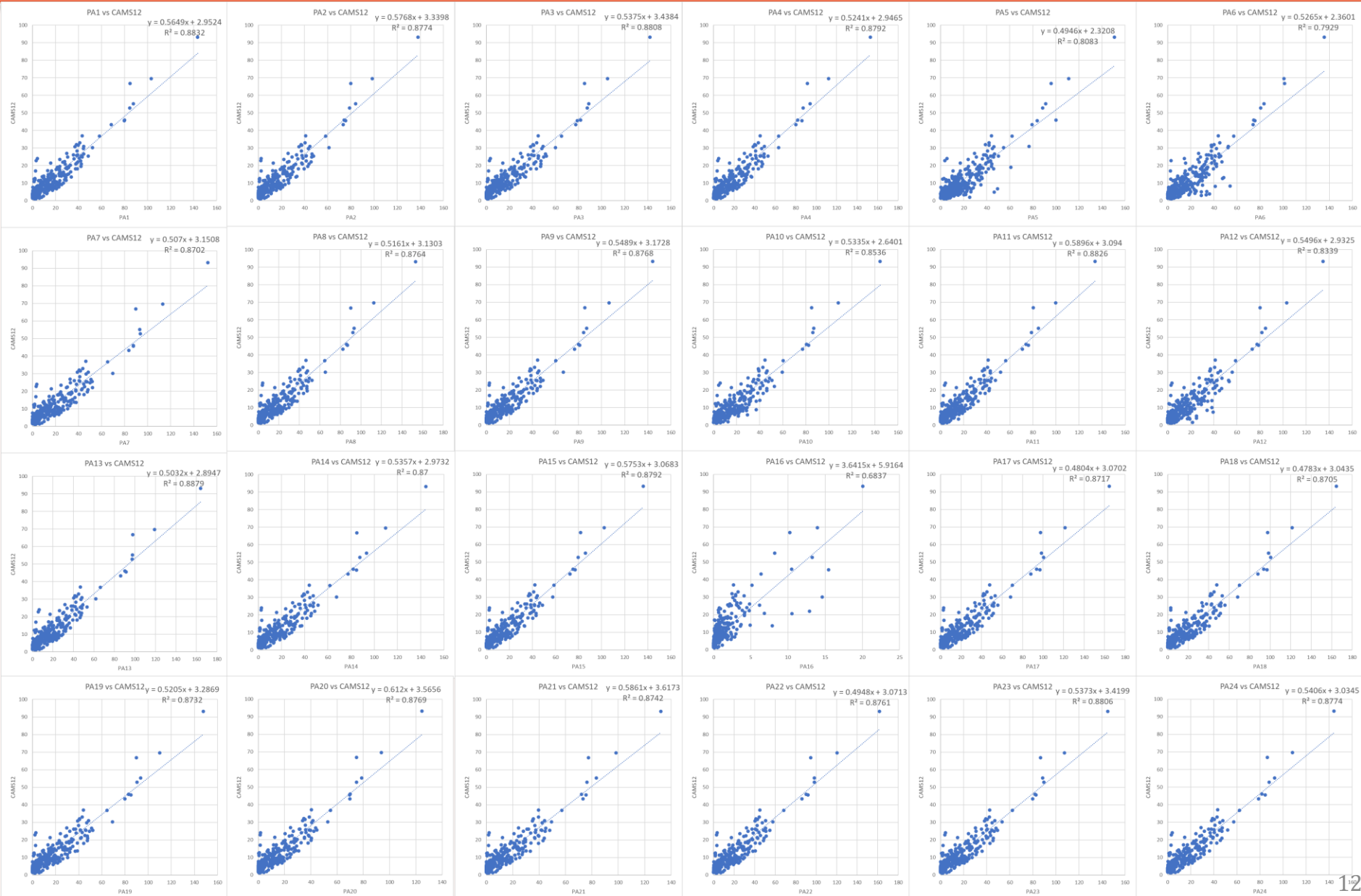


# Pre-Calibration Results (Time Series)



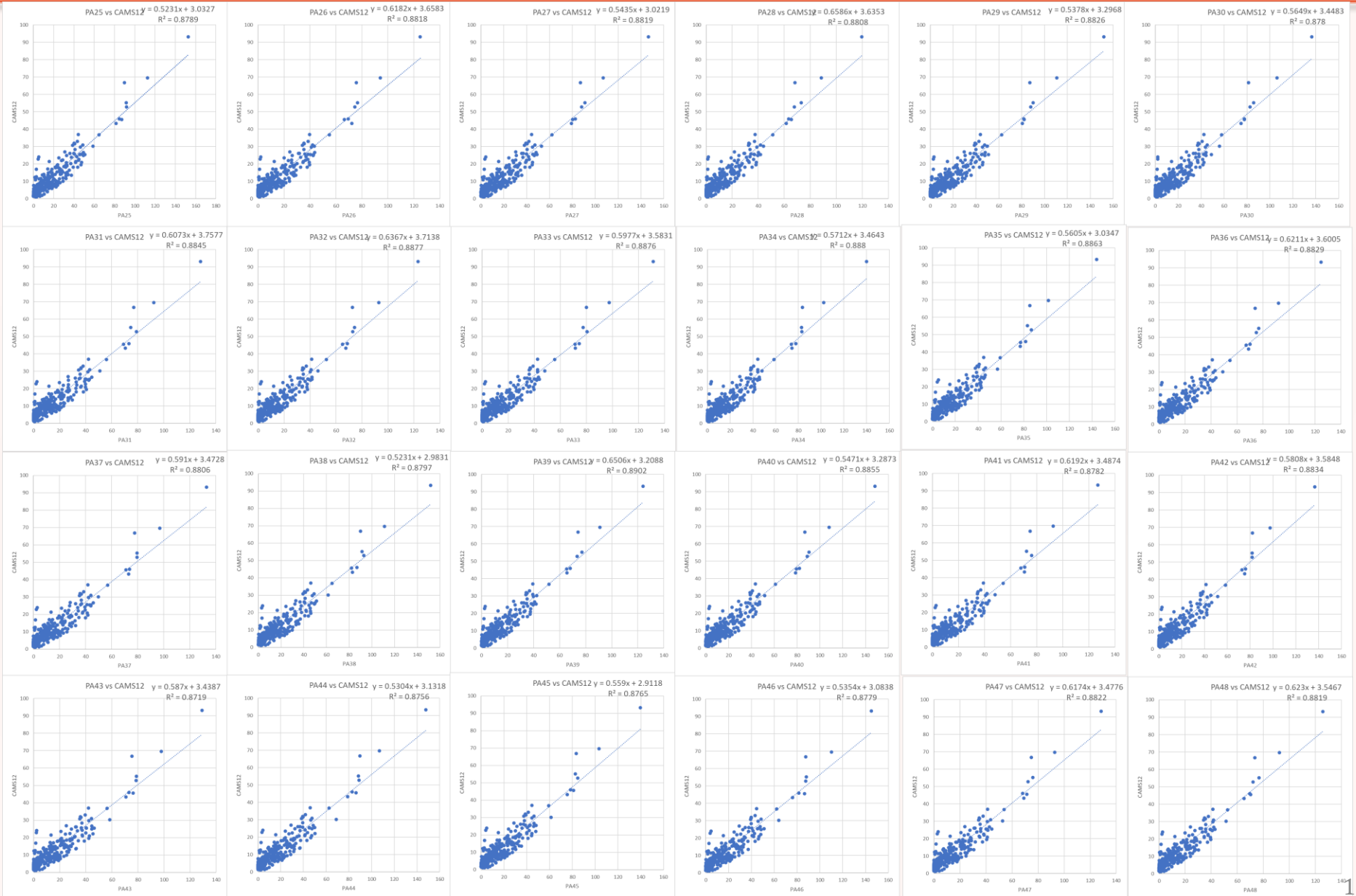


# Correlation Plot (TCEQ CAMS12)



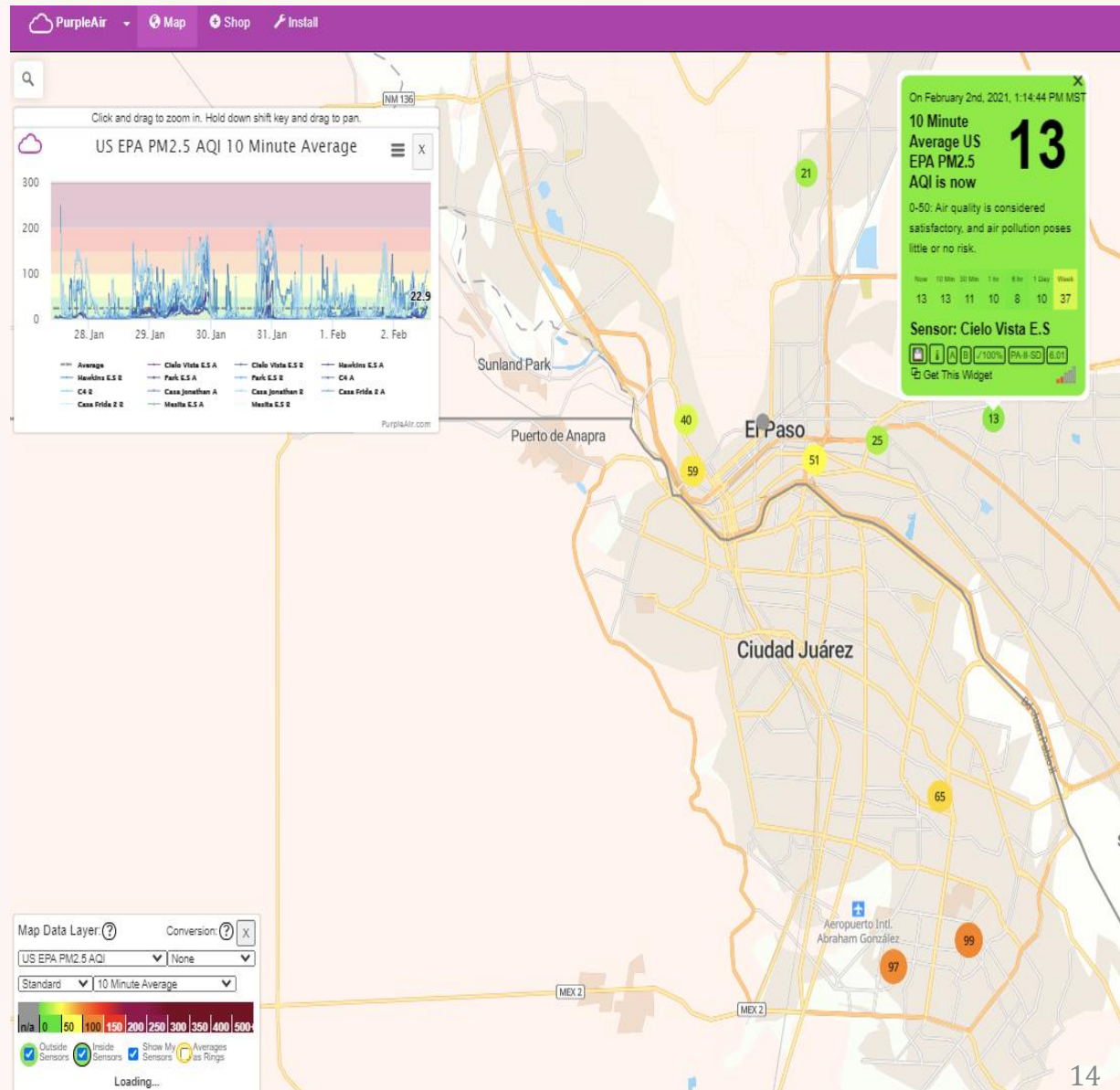


# Correlation Plot (TCEQ CAMS12)



# Purple Air Website

## Website



# Example: Installation Logbook

1/3

UACJ

## FORMATO DE INSTALACIÓN DE PURPLE AIR



Fecha de la instalación	27-01-2021	Hora de la instalación	01:44 pm
-------------------------	------------	------------------------	----------

DATOS GENERALES DEL MONITOR	
Identificación del monitor	C 48 (10:52:10:40:84:53)
Ubicación:	1-CJ7 Sector Tac Milenio
Dirección:	Calle Via Aereo #9833-11 Fono. Guardias Residencial
Contacto responsable:	Jonathan Jacobo Hernandez
Teléfono:	656-642-0882
Categoría:	AHo AADT

EVIDENCIA FOTOGÁFICA DE LA INSTALACIÓN	DATOS DEL SITIO	
	Altura con respecto al suelo	0.5m de cornisa al equipo 6.56m de Piso a cornisa
	Obstrucciones visibles	
	Condiciones meteorológicas	Cielo despejado
Observaciones Generales		

Contacto responsable		Técnico instalador	
Nombre:	Jonathan Jacobo Hernandez	Nombre:	Adrian Peña
Teléfono:	656 642 0882	Teléfono:	656 42 0882
Firma:		Firma:	

Clave: Jonathan 9106



2/3

UACJ

## FORMATO DE INSTALACIÓN DE PURPLE AIR



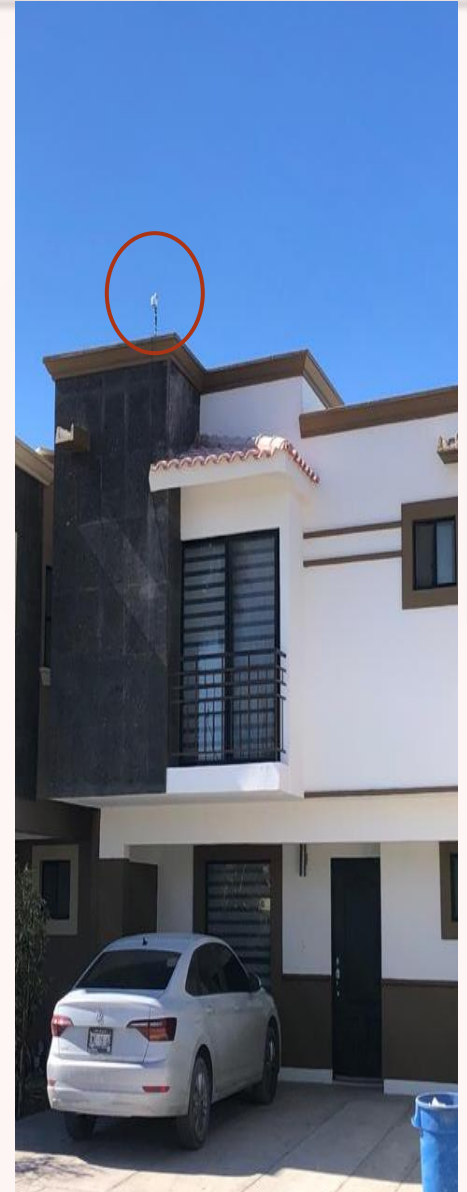
Fecha de la instalación	27-01-2021	Hora de la instalación	01:44 pm
-------------------------	------------	------------------------	----------

DATOS GENERALES DEL MONITOR	
Identificación del monitor	C 48 (10:52:10:40:84:53)
Ubicación:	1-CJ7 Sector Tac Milenio
Dirección:	Calle Via Aereo #9833-11 Fono. Guardias Residencial
Contacto responsable:	Jonathan Jacobo Hernandez
Teléfono:	656-642-0882
Categoría:	AHo AADT

EVIDENCIA FOTOGÁFICA DE LA INSTALACIÓN	Vista Norte		Vista Este	

Sitio seleccionado para instalación

# Pictures of UACJ sites





# Pictures of EPISD sites



# Trabajos de investigación

- En la UACJ hay tres estudiantes de licenciatura que obtendrán su título de Ingenieros Ambientales como parte del desarrollo del proyecto.
  - 1) *Evaluación comparativa entre sensores de bajo costo durante la campaña de monitoreo de la region Paso del Norte.*
  - 2) *Análisis de  $PM_{2.5}$  en vialidades de alto y bajo flujo vehicular en Ciudad Juárez usando sensores de bajo costo.*
  - 3) *Sesgo en el uso de sensors de bajo costo como parte de la campaña de monitoreo de la Region Paso del Norte utilizando dos tecnologías.*

- February 2021: Acquire annual traffic and GIS information
- April 2021: Completion of Field Measurement
- May 2021: Data analysis
  - Data processing and cleaning
  - Basic statistical methods.
  - Data analysis: Regression analysis techniques for data interpretation and organization
  - Data visualization (reports and interactive webpage)
  - Data will be sent to a local server for processing, cleaning, analysis, and visualization.
- June 30, 2021: Publication of data online
- June 30, 2021: Presentation to the JAC
- July 31, 2021: Final Report

## UTEP

Wen-Whai Li, Ph.D., P.E. (Co-Principal Investigator)

[wli@utep.edu](mailto:wli@utep.edu)

Adrian Vazquez Galvez, Ph.D. (Co-Principal Investigator)

[fvazquez@uacj.mx](mailto:fvazquez@uacj.mx)

Mayra Chavez, Ph.D. (Co-Principal Investigator)

[mcchavez4@utep.edu](mailto:mcchavez4@utep.edu)

## TCEQ Staff

Melanie Scruggs

TCEQ Senior Program Coordinator

Border Affairs, Intergovernmental Relations

Texas Commission on Environmental Quality

[Melanie.Scruggs@tceq.texas.gov](mailto:Melanie.Scruggs@tceq.texas.gov)

## UACJ

Yazmín Hernández García, M.S. (Co- Investigator)

[yazmin.hernandez@uacj.mx](mailto:yazmin.hernandez@uacj.mx)

Frida Toquinto Manjarrez, Engr. (Co- Researcher)

[Frida.toquinto@uacj.mx](mailto:Frida.toquinto@uacj.mx)

Alejandro Iván Vega Rodríguez, B.A. (Project Coordinator)

[alejandro.vega@uacj.mx](mailto:alejandro.vega@uacj.mx)