

ASIC 2024  
Air Sensor International Conference



## **Real-Time Remote Emissions Monitoring of Heavy-Duty Vehicles: An Enforcement Tool to Detect High-Emitters in California**

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May 1<sup>st</sup>, 2024

# Inspections on Heavy-Duty Diesel Vehicles in California

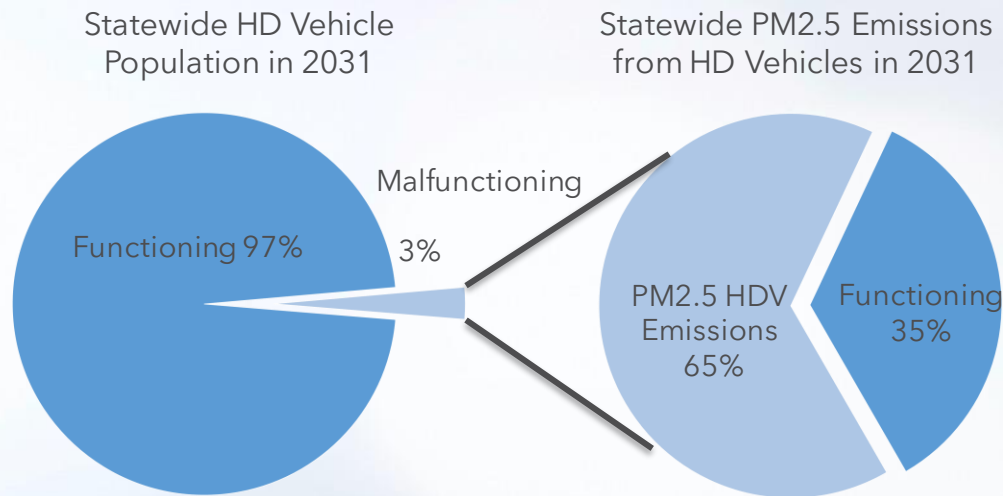


## Identification of High-Emitting Vehicles

- Roadside Inspections
- CHP Weigh Scales

CARB regularly conducts enforcement inspections on heavy-duty diesel vehicles statewide, collaborating closely with CHP.

Why do we want to identify the highest emitters?



Estimated emissions due to HDV malfunction for PM 2.5

# PEAQs: A Remote Sensing Device in Enforcement

Environmental Justice Community in Greater LA Area

HD vehicle will pass underneath the sampling boom (updraft sampling)



Screening with a mobile deployment platform and inspecting HD vehicles in conjunction with California Highway Patrol (CHP)

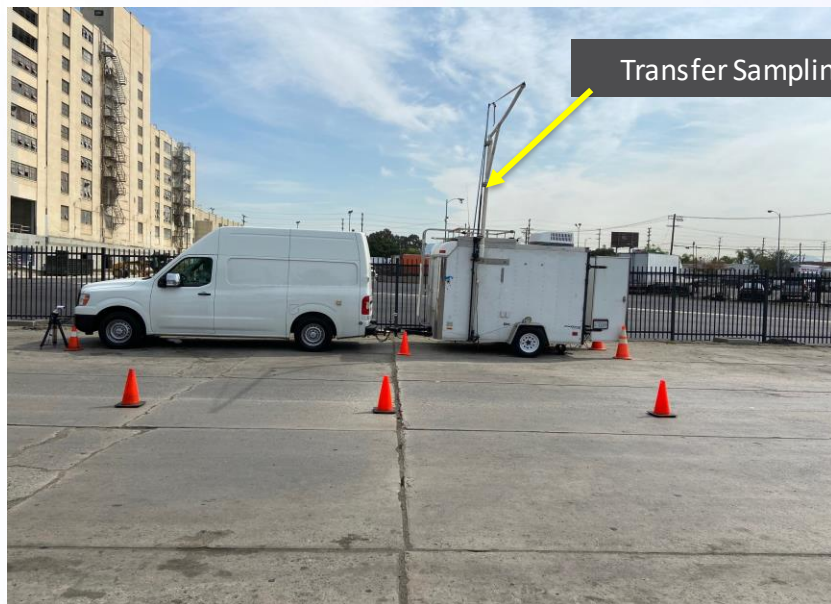
## Portable Emission AcQuisition System

During Mobile PEAQS Operations:

- PEAQS measures vehicle exhaust as vehicles pass under the sampling boom.
- CARB Enforcement monitors emissions in real-time.
- The highest emitters are selected for full vehicle inspection.

# PEAQS – Remote Sensing Device in Enforcement

Mobile Deployment Platform - **Trailer**



Transfer Sampling Line (PVC)

Mobile Deployment Platform - **Van**



The PEAQS van streamlines roadside inspections, reducing setup time and resource requirements

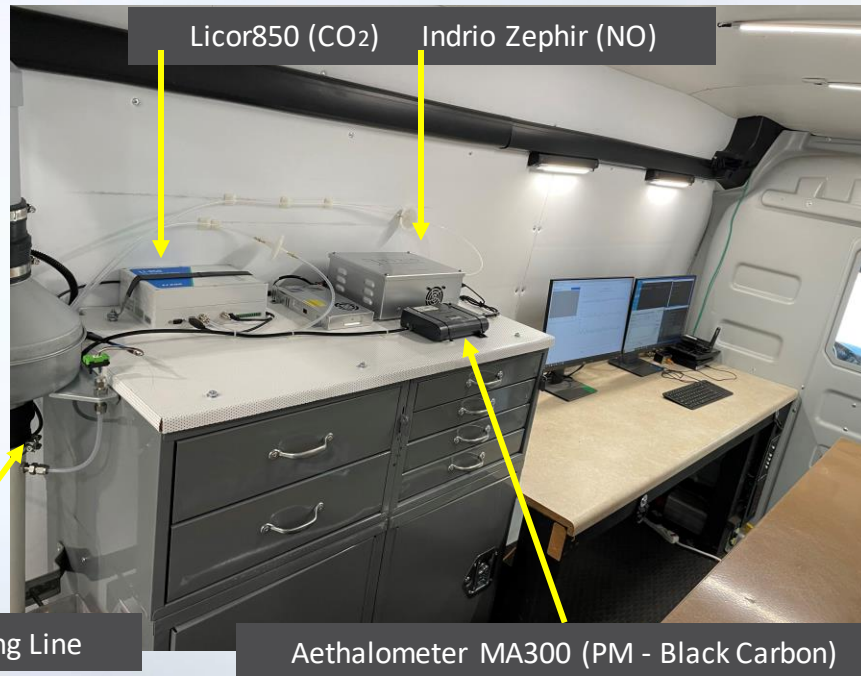


# PEAQS - Remote Sensing Device in Enforcement

Mobile Deployment Platform - Outside View



Mobile Deployment Platform - Inside View

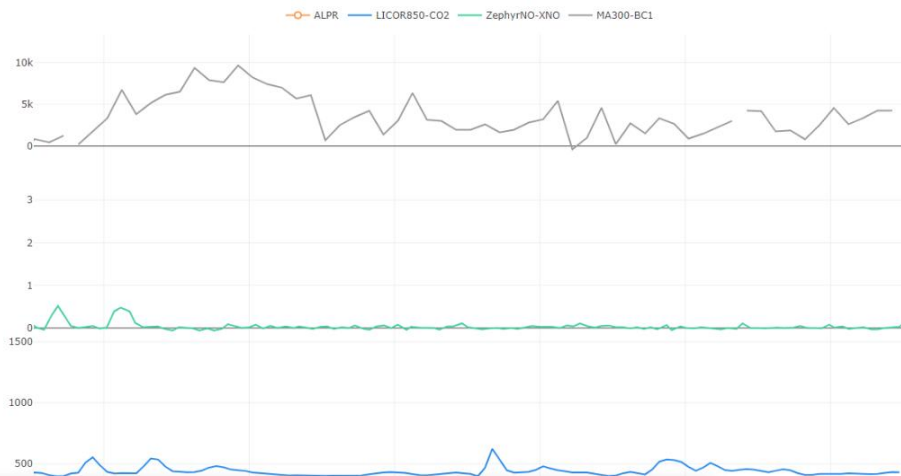


Roadside Screening: Analyzing CO<sub>2</sub>, NO<sub>x</sub>, and PM(Black Carbon - 880nm wavelength) Using the Plume Capture Method.

# PEAQS - Remote Sensing Device (GUI - Scripts)



TIME	PLATE	REGION	RESULT
13:31:19	79EN1E	MX-JAL	Analyzing...
13:31:19	79EN1E	US-CA	CLEAN
13:31:13	79EN1E	MX-JAL	CLEAN
13:31:10	79EN1E	MX-JAL	Analyzing...



```
Command Prompt
PRELIMINARY Truck counts on 2024-02-26
Total tractors screened by PEAQS: 351
Tractors screened more than once: 2

UNIQUE Tractors Counts:      349

Tractors reg. In-State (CA): 219 62.8%
Tractors reg. Out-State (US): 130 37.2%

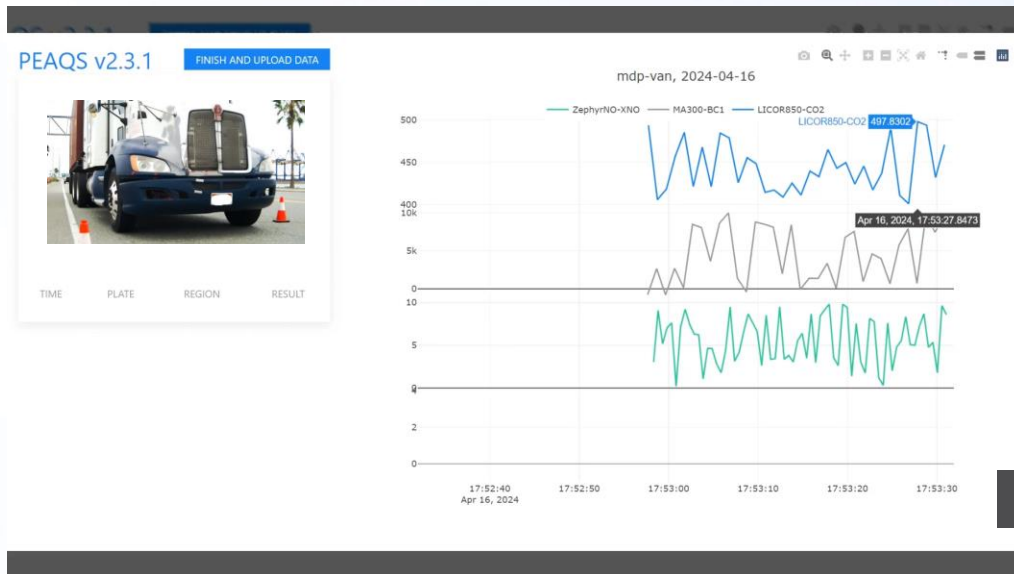
-----
saving clean copy...
saved!
```

```
Command Prompt
Loading blacklist...
Done! Elapsed time: 1.588460 seconds to load 864646 elements

Searching License Plate (exit 'ctrl + c')...
License Plate @ NOT FOUND in the blacklist.

yyyy-mm-dd hh:mm:ss..... | Black LP | List
-----
2024-01-08 11:46:12.390548 | 00000000 | TEST
2024-01-09 09:52:14.364504 | 00000000 | STB_2010
2024-01-09 11:18:44.565123 | 00000000 | STB_2010
2024-01-09 13:01:15.461895 | 00000000 | STB_2010
2024-01-10 10:07:20.486090 | 00000000 | STB_2010
2024-01-10 11:14:32.696141 | 00000000 | STB_2010
2023-11-08 14:28:04.486008 | 00000000 | TEST
2023-11-08 14:28:04.486008 | 00000000 | GLIDER_GGGG
2024-02-26 11:28:04.486008 | 00000000 | LOW2023
```

# Portable Emission AcQuisition System (PEAQS)



PEAQS is a plume-capture on-road heavy-duty vehicle emissions screening system



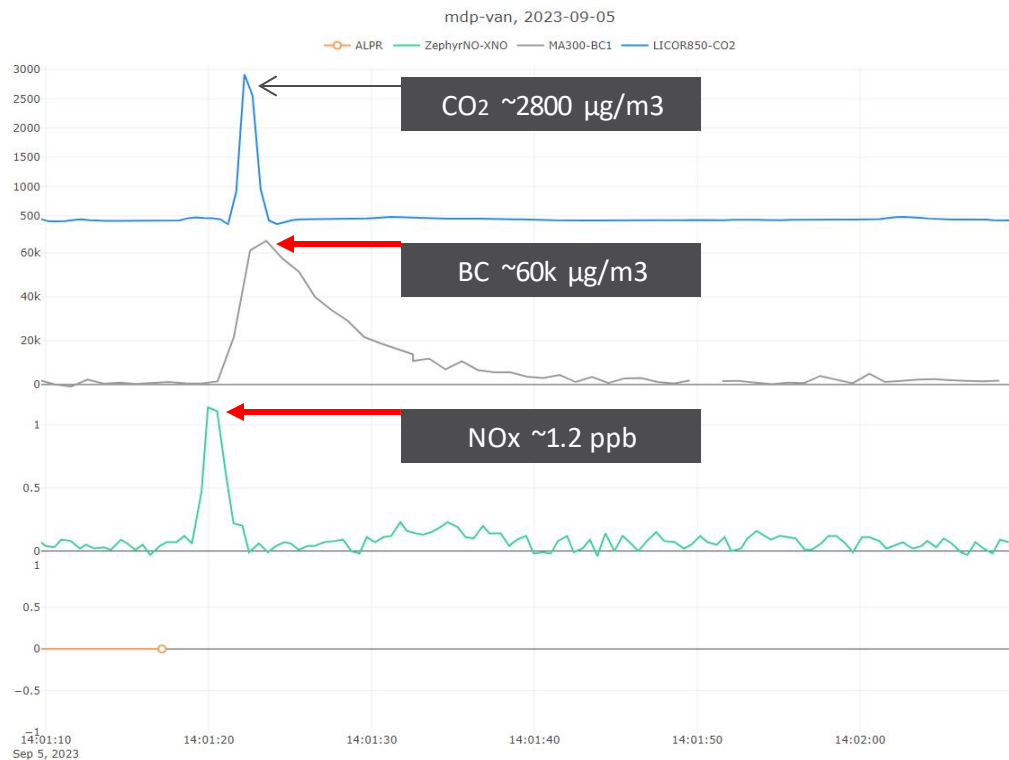
# PEAQS - Remote Sensing Device (GUI)

PEAQS v2.3.1

FINISH AND UPLOAD DATA

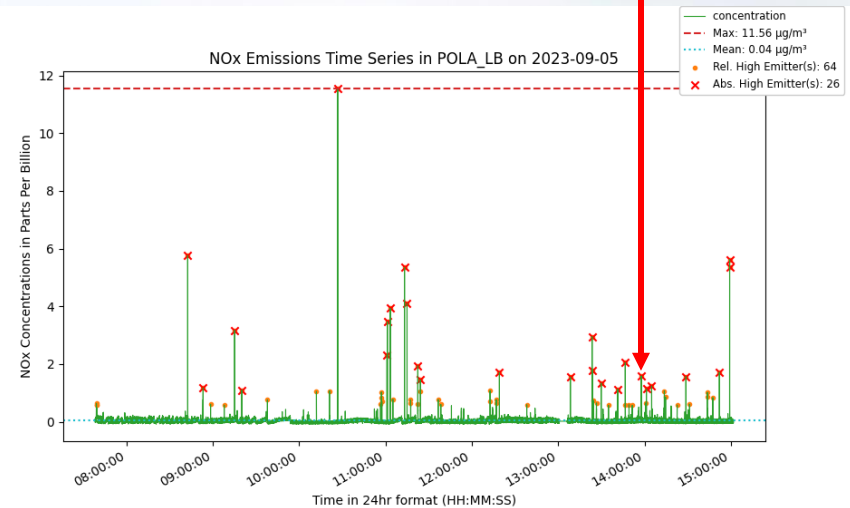
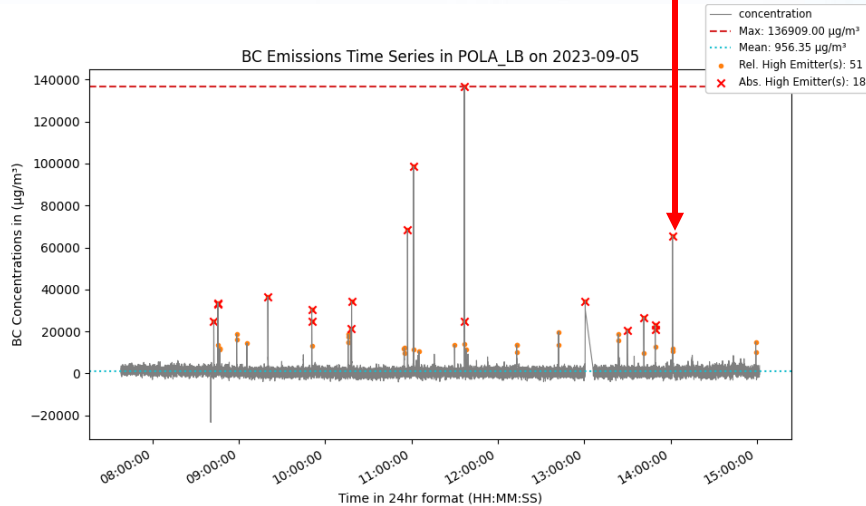


TIME	PLATE	REGION	RESULT
14:01:52	9F9880	US-CA	N/A
14:01:14	9F9880	US-CA	N/A
14:01:03	9F9880	US-OH	N/A
14:00:58	9F9880	US-NJ	N/A
14:00:51	9F9880	US-FL	N/A
14:00:48	9F9880	US-CA	N/A
13:58:42	9F9880	US-MI	N/A
13:58:27	9F9880	US-OH	N/A

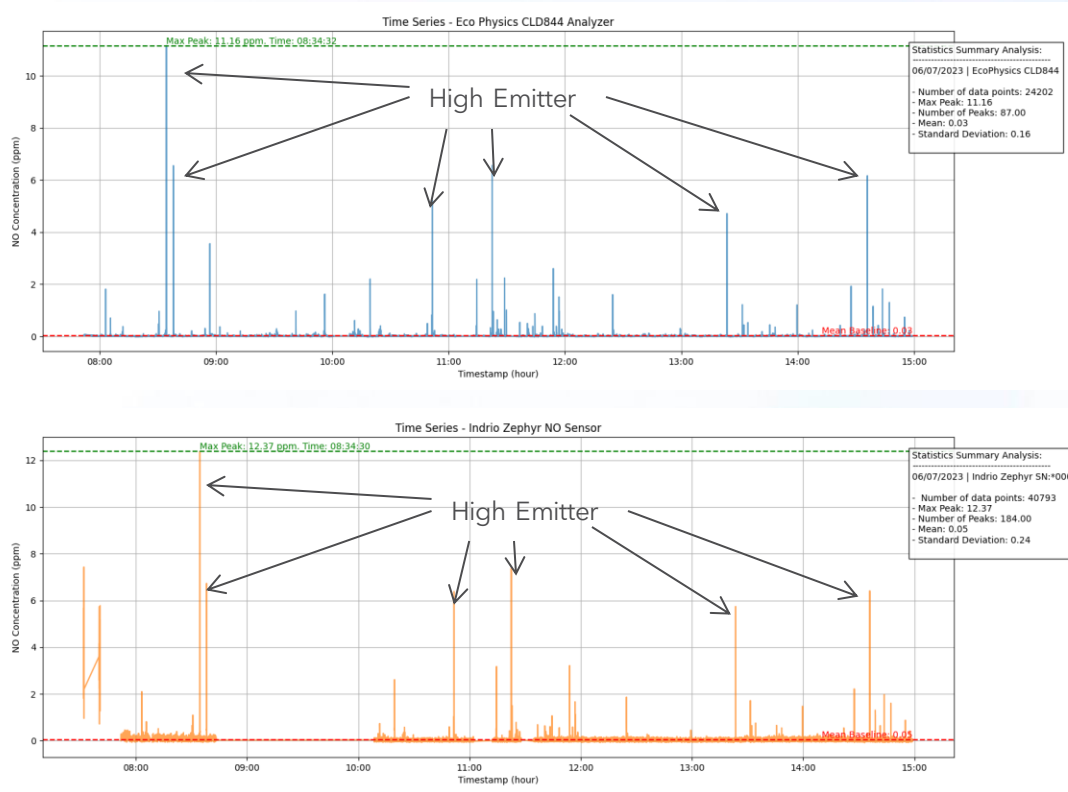




# PEAQS - Mobile Deployment Platform Time Series Plot



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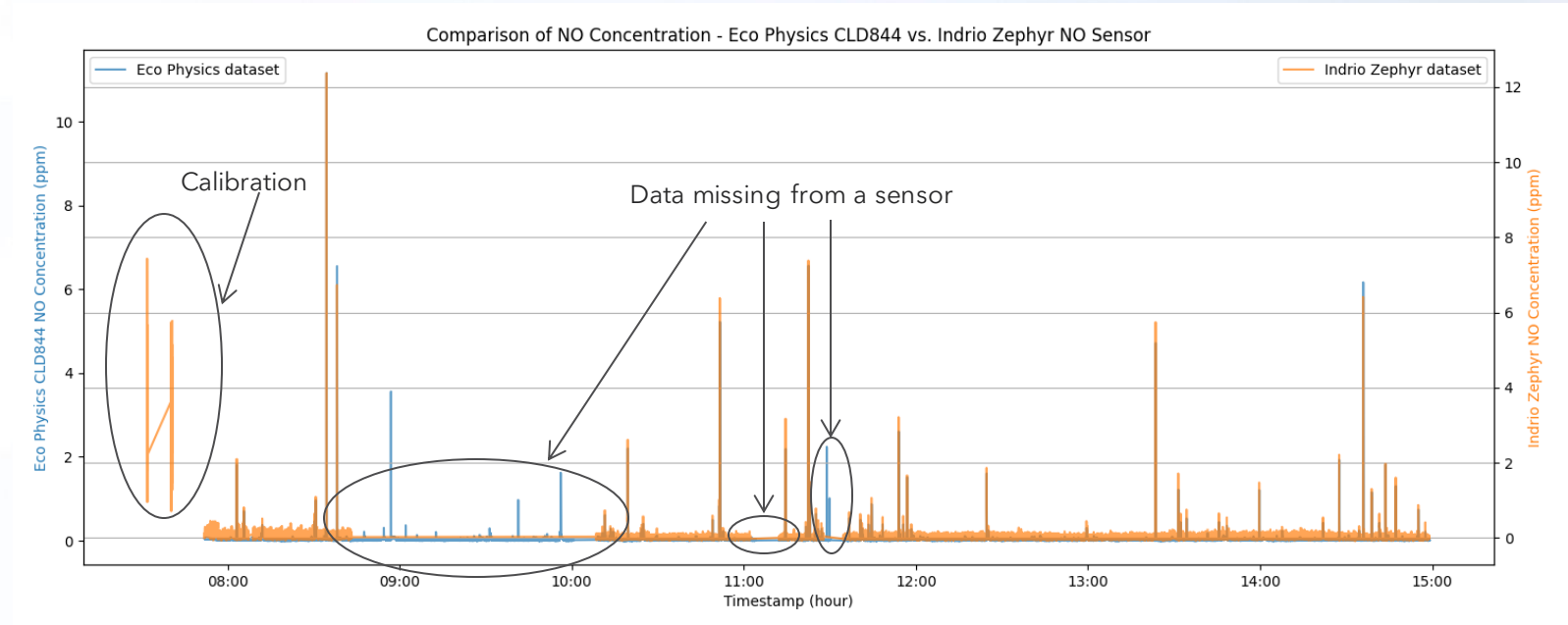
Data comparison from a lab-grade analyzer and a mid-grade sensor was collected on the same day and location.

Redundancy for plume capture emissions:

- Reliability and Accuracy
- Validation and Verification QA/QC
- Redundancy

Extreme NO<sub>x</sub> concentrations may indicate tampering with the after-treatment system, such as the removal of Diesel Particulate Filters (DPF) or Selective Catalytic Reduction (SCR) systems.

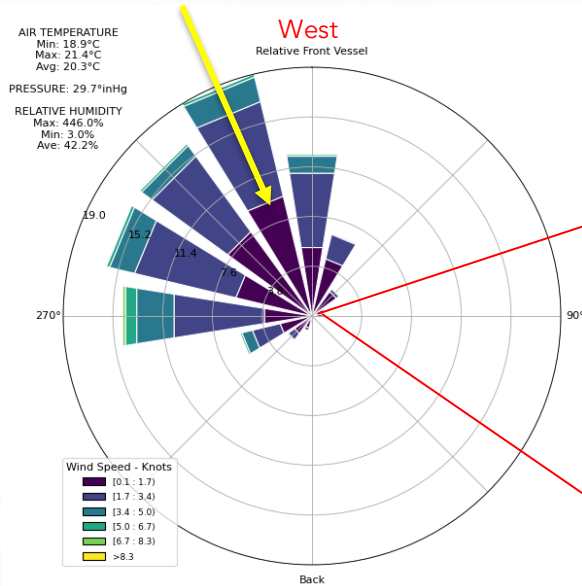
# PEAQS - Mobile Deployment Platform Time Series Plot



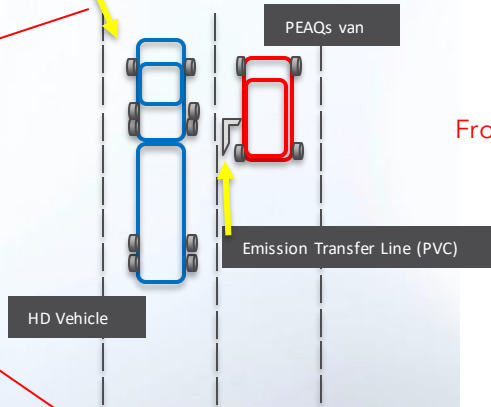
Side-by-Side Comparison of NO<sub>x</sub> Emissions Time-Series Plots: Utilizing Multiple Sensor-Analyzers for Redundancy in Deployment and Data Analysis

# PEAQs - Mobile Deployment Platform Windrose Plot

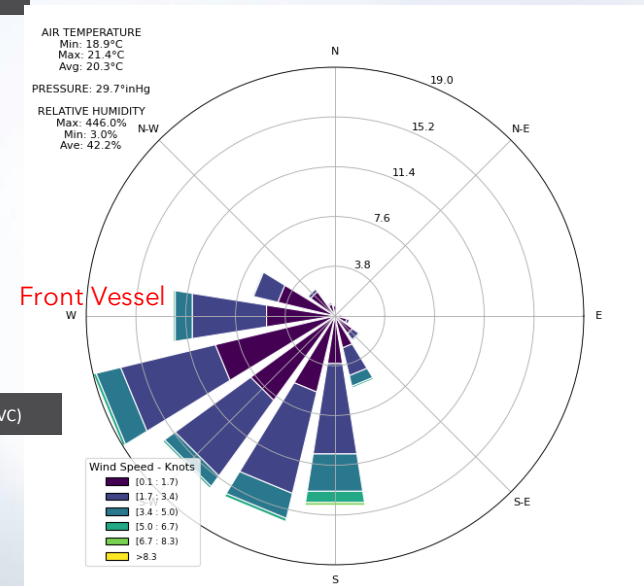
Wind speed and direction based on  
Mobile Deployment Platform **position**



Wind Direction: ~ 247.5° West-Southwest  
Wind Speed: ~ 19 Knots



Wind speed and direction vectors are  
oriented with its internal **Magnetic North**.



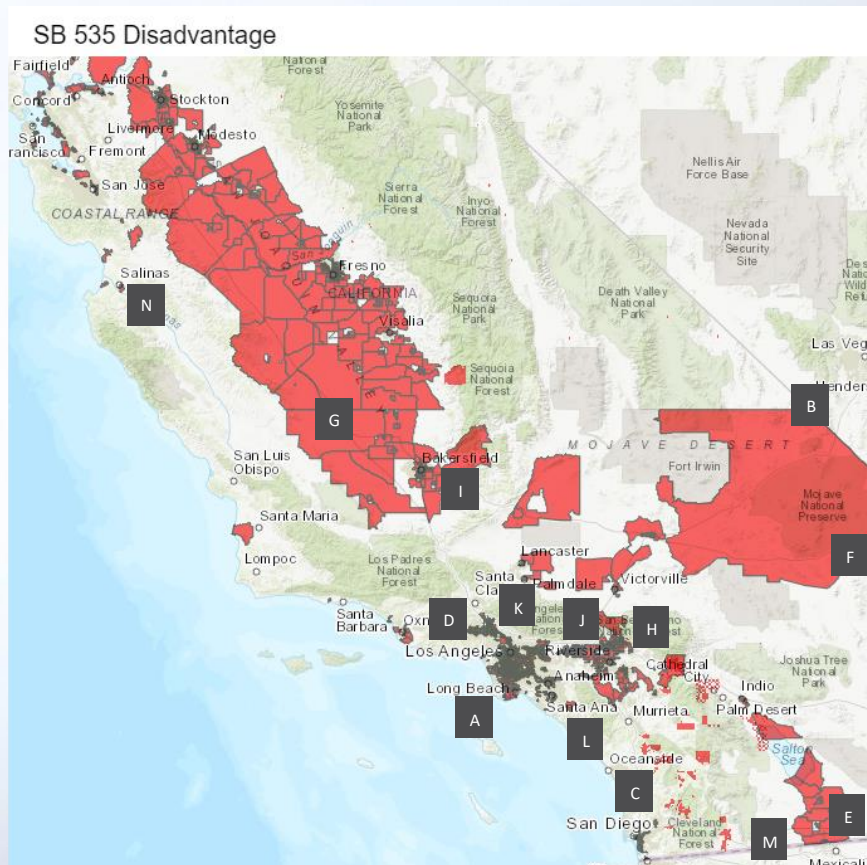
# PEAQS - Mobile Deployments at EJ Communities

Data Results in 2023

Location	HDV Screened	Inspection	Citations	Ratio
A	3482	119	64	53.80%
B	2477	16	12	75.00%
C	2278	65	37	56.90%
D	1891	94	41	43.60%
E	1624	27	23	85.20%
F	1191	11	4	36.40%
G	887	44	20	45.50%
H	856	41	18	43.90%
I	484	61	24	39.30%
J	431	19	9	47.40%
K	361	43	22	51.20%
L	343	47	13	27.70%
M	298	16	8	50.00%
N	174	51	24	47.10%
<b>TOTAL</b>	<b>16777</b>	<b>654</b>	<b>319</b>	<b>48.8%</b>

\*\* Ratio = Citation/Inspection

[SB 535 Disadvantaged Communities | OEHA \(ca.gov\)](https://oehha.ca.gov/sb535)





# Conclusion

**Purpose:** It supports the Heavy-Duty Inspection and Maintenance program, known as Clean Truck Check <https://ww2.arb.ca.gov/our-work/programs/CTC>

**Functionality:** Remote Sensing Devices such as PEAQS can be integrated into different Mobile Deployment Platform versions to aid in identifying high-emitting vehicles during inspections.

**Enforcement:** Citations are not based on PEAQS concentration results. CARB inspectors use their expertise to determine compliance with CARB regulations.

**Inspection:** Vehicles flagged for high Black Carbon concentrations undergo a thorough inspection following SAE J1667 snap-acceleration test procedure standards as smoke opacity testing.

# Additional Information

## **Truck and Bus Schedules**

Lighter Vehicles (14,001 - 26,000 lbs. GVWR)

Engine Model Year	Replace or Repower
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2002-2003 MY Engines	January 1, 2020
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2004-2006 MY Engines	January 1, 2021
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2007-2009 MY Engines	January 1, 2023
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## **Opacity Limits**

Engines Equipped with a DPF 5% Opacity Limit

## **Pre-2007 Model Year (MY) Engines not Equipped with a DPF**

1997-2006 MY Engines	20% Opacity Limit
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1991-1996 MY Engines	30% Opacity Limit
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Pre-1991 MY Engines	40% Opacity Limit
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## **Regulatory**

13 CCR § 2195

HD I/M Tampering

13 CCR § 2195

HD I/M - MIL on

13 CCR § 2195

HD I/M - ECL missing

13 CCR § 2195

HD I/M - Smoke opacity limits

13 CCR § 2025

STB In-use standards ATCM

13 CCR § 2477

TRU Non-Compliant

[https://ww2.arb.ca.gov/sites/default/files/2020-11/PSIP\\_booklet\\_Sept2020\\_spreads.pdf](https://ww2.arb.ca.gov/sites/default/files/2020-11/PSIP_booklet_Sept2020_spreads.pdf)

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**THANK YOU**

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