

# Elemental content of brake and tire wear PM2.5 and PM10 at near-road environments

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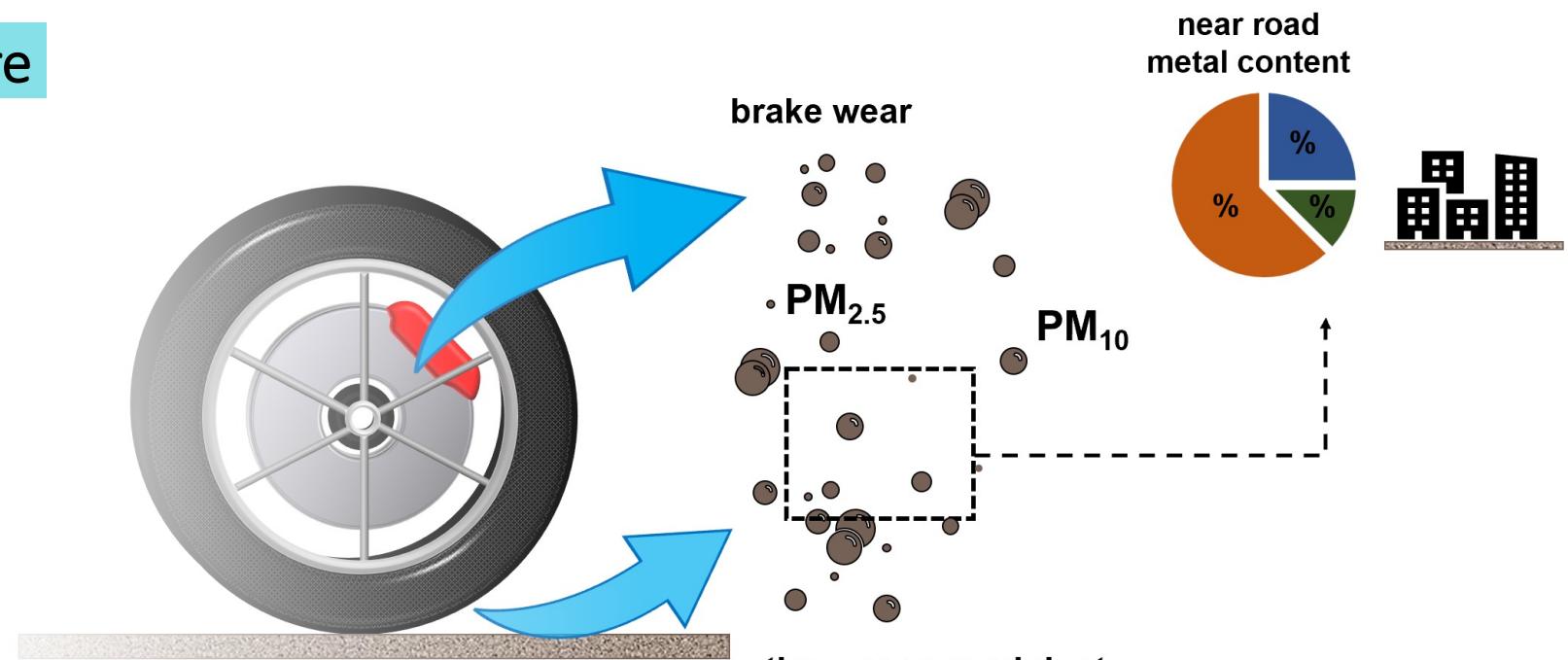
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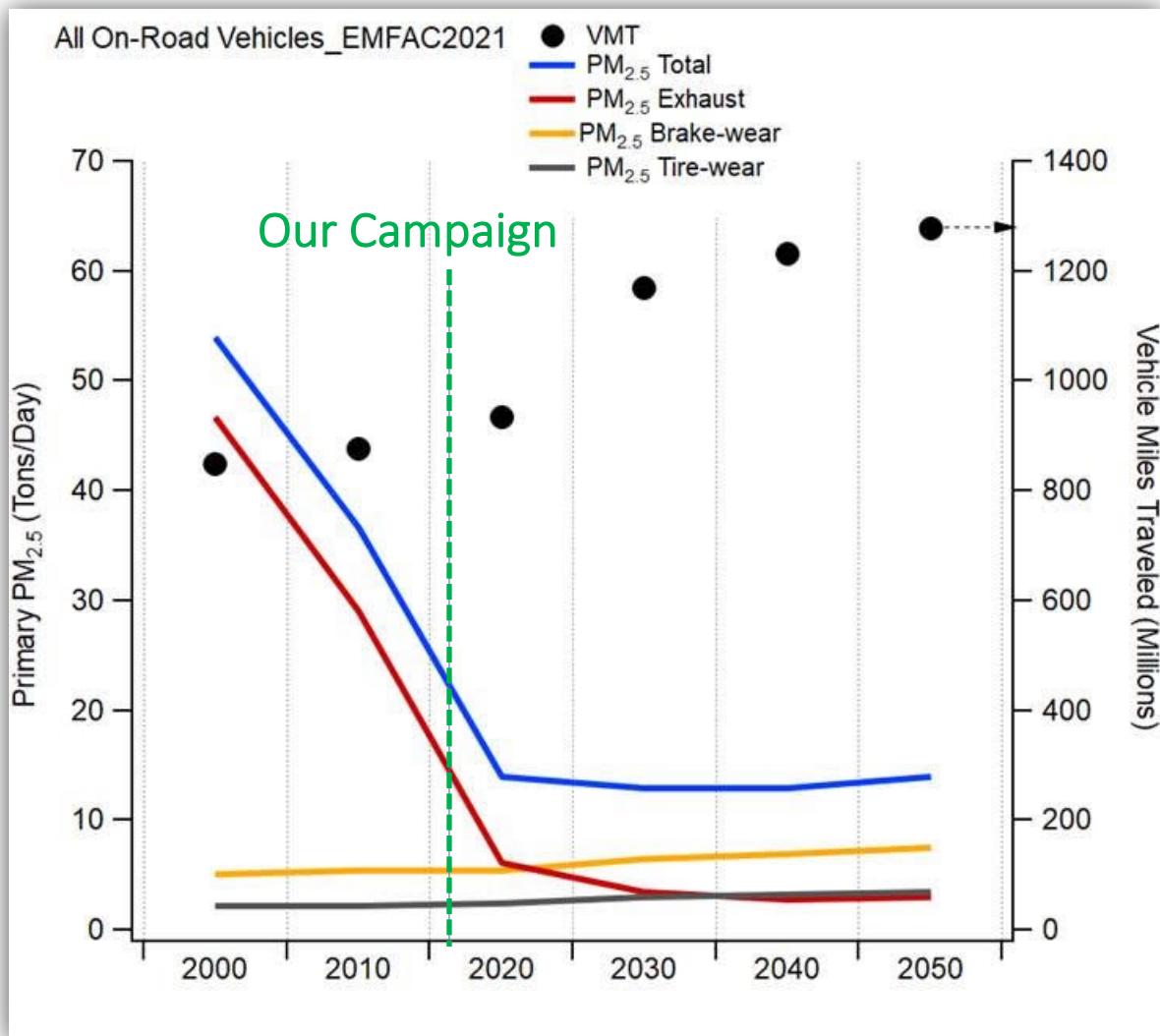
6/20/23

# Objective and Hypotheses

- to assess the level of exposure of non-tailpipe emissions at near-road environments
  - can contain heavy-metals and may dominate metal emission near major roadways
  - can be distinguishable in particle size distributions and chemical composition



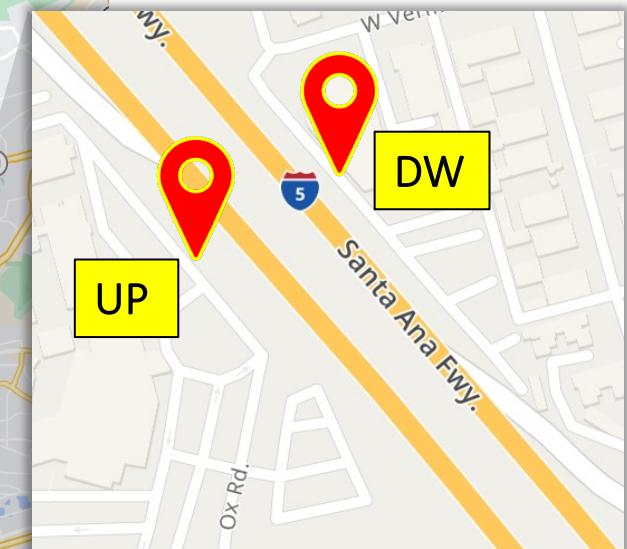
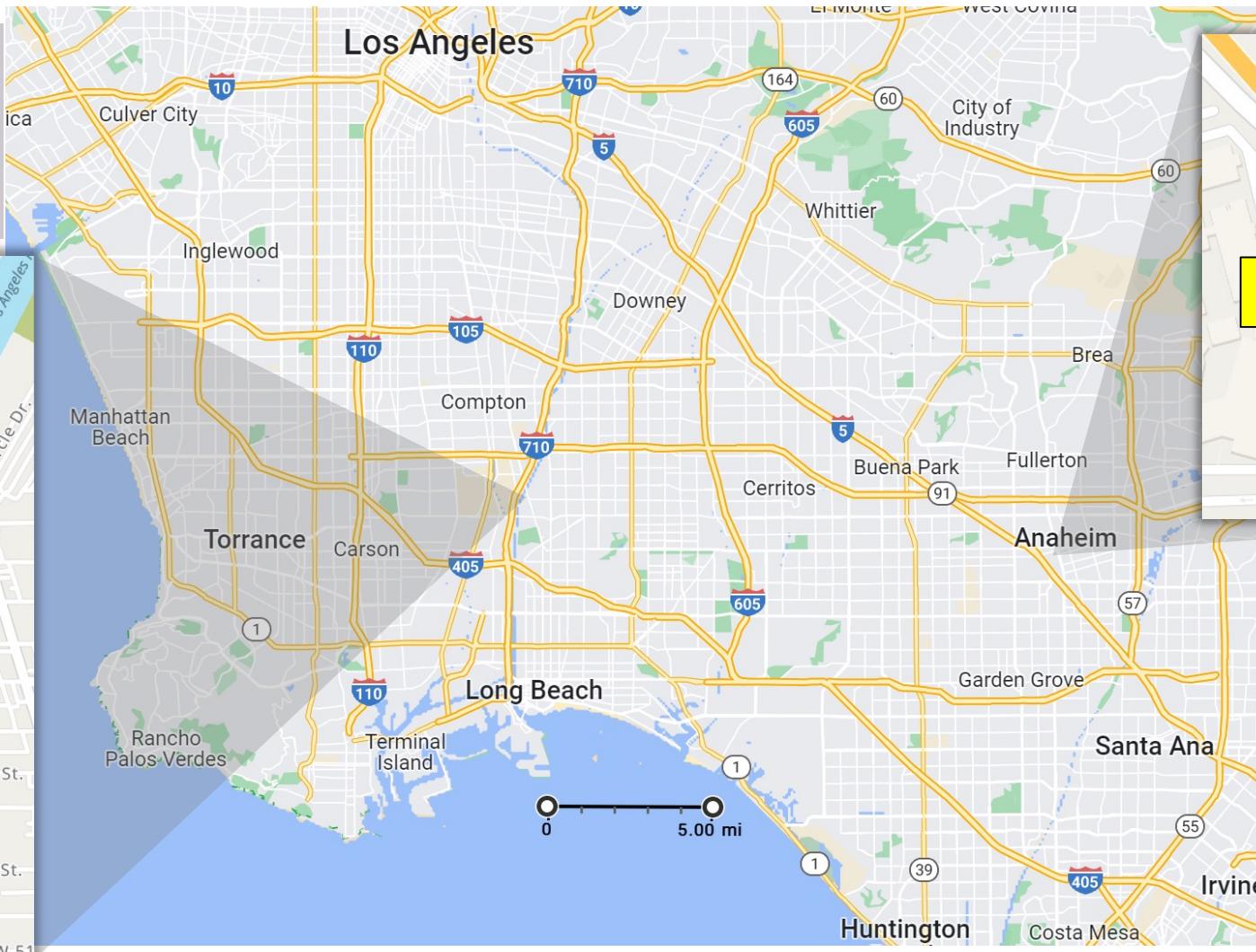
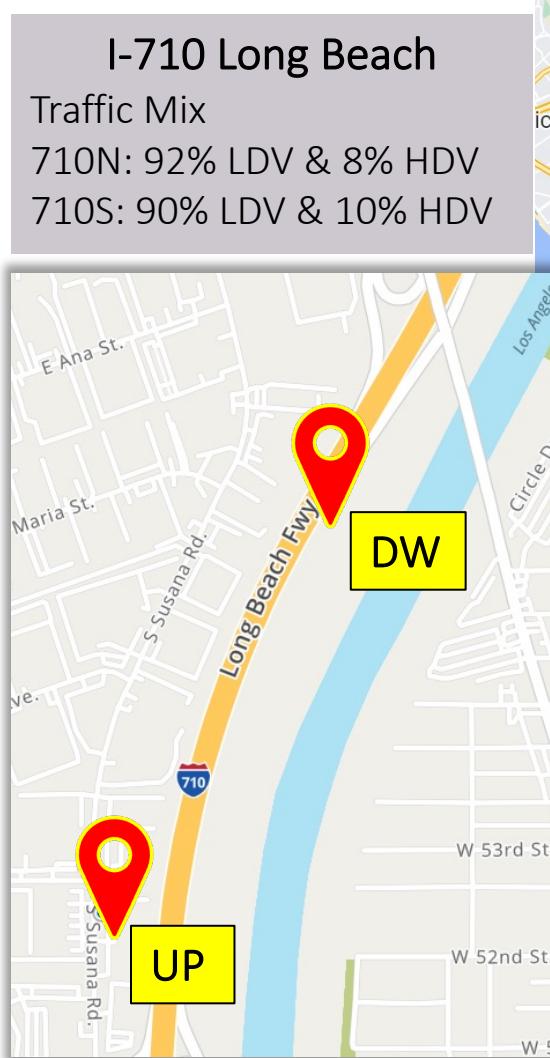
# California Emission Inventory



EMFAC 2021 emission prediction

- PM<sub>2.5</sub> emission is decreasing while non-exhaust emission is increasing
- Non-tailpipe : Brake + Tire emission

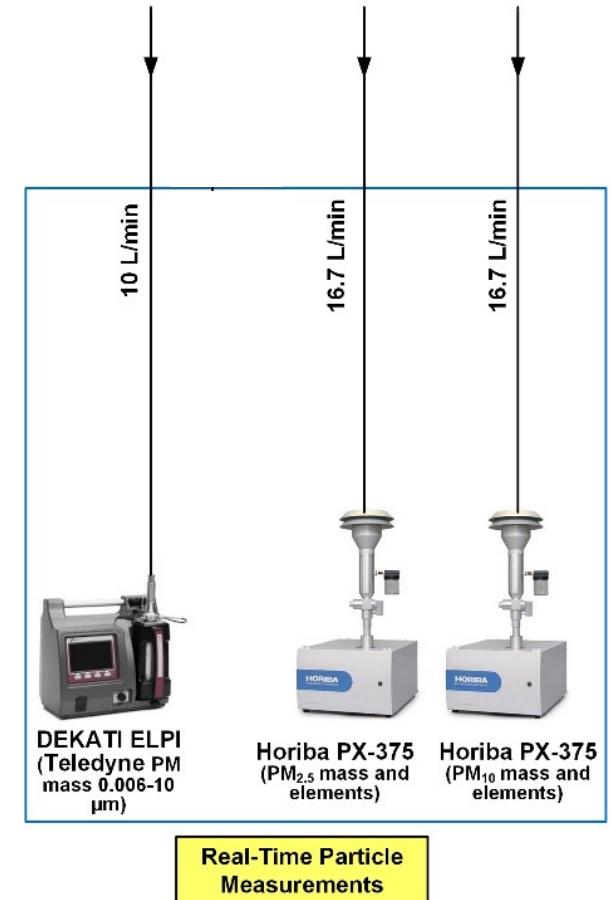
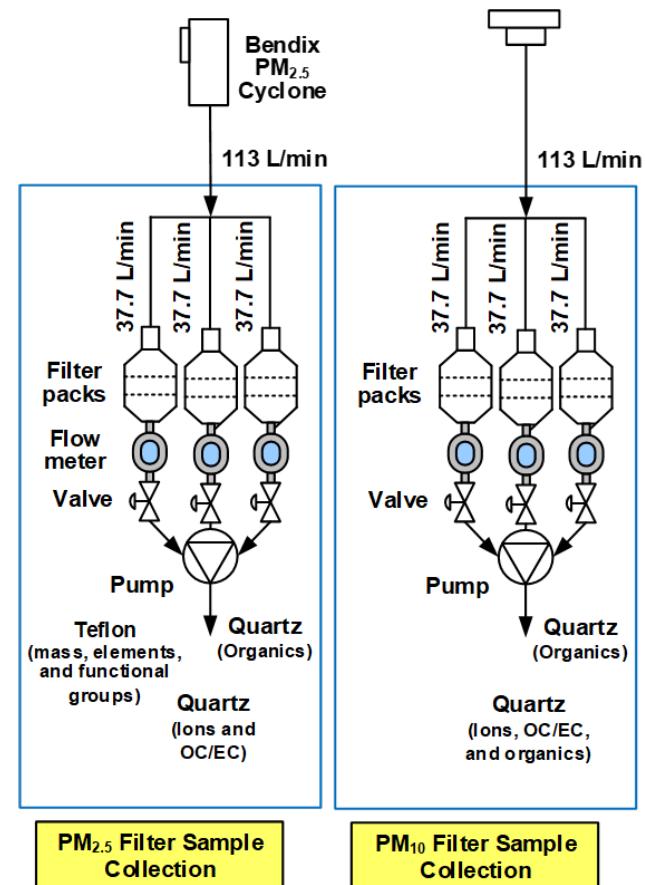
# Measurement Sites 1/28/20 – 2/10/20



**I-5 Anaheim**

Traffic Mix  
I-5N: 96% LDV & 4% HDV  
I-5S: 95% LDV & 5% HDV

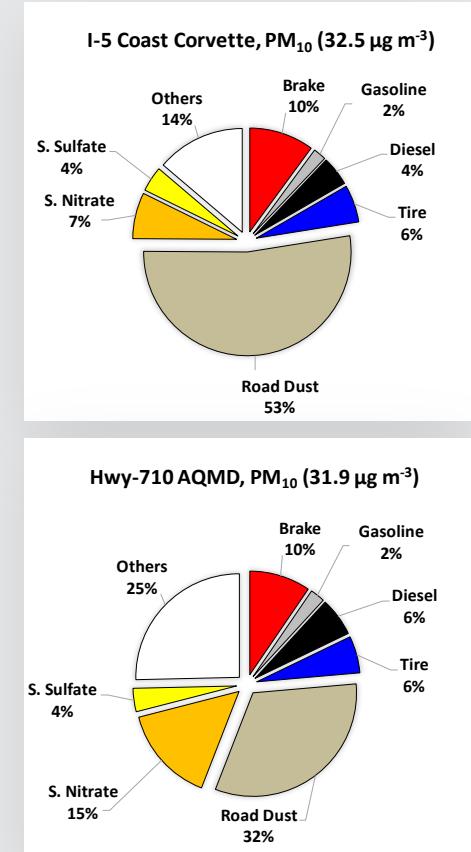
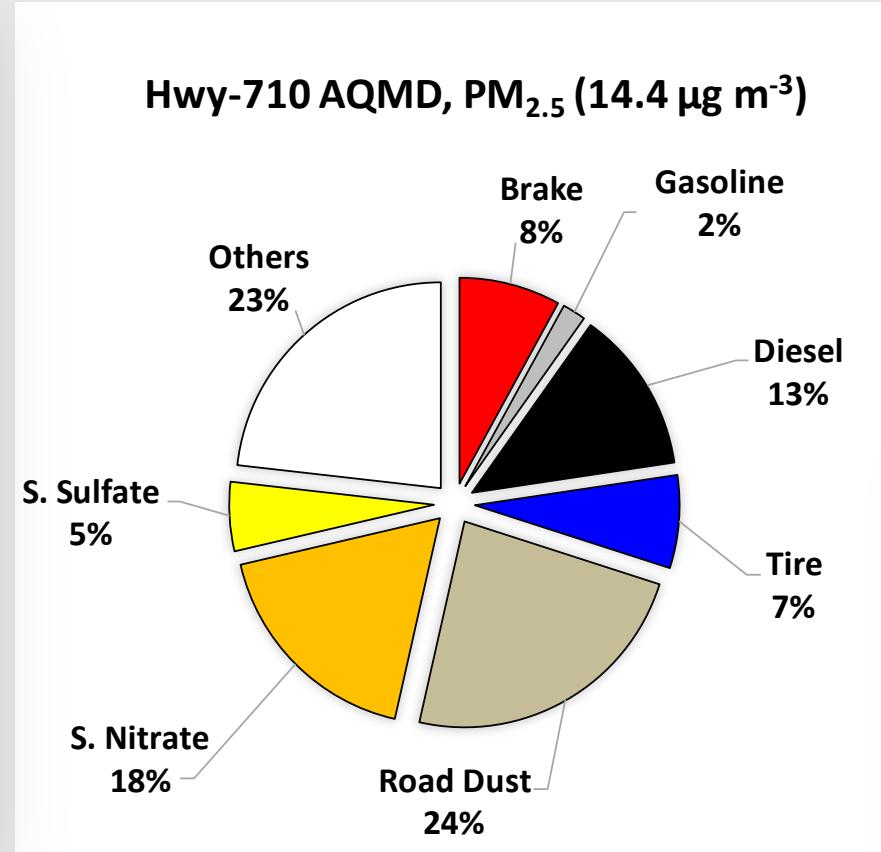
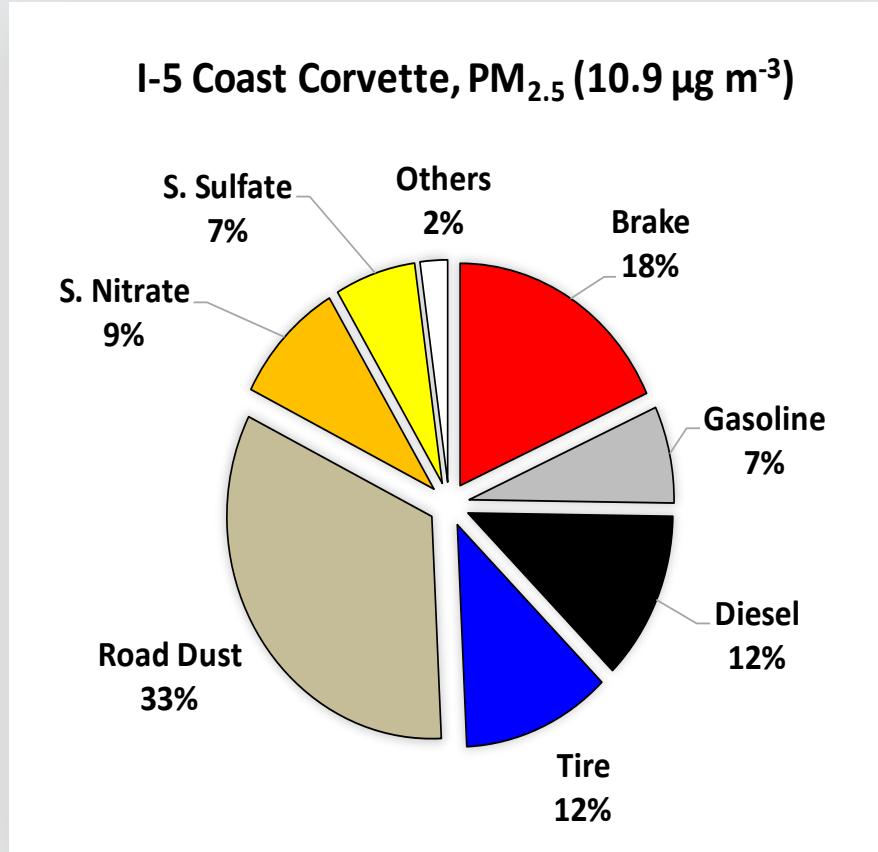
# PM<sub>2.5</sub> & PM<sub>10</sub> sampling upwind / downwind



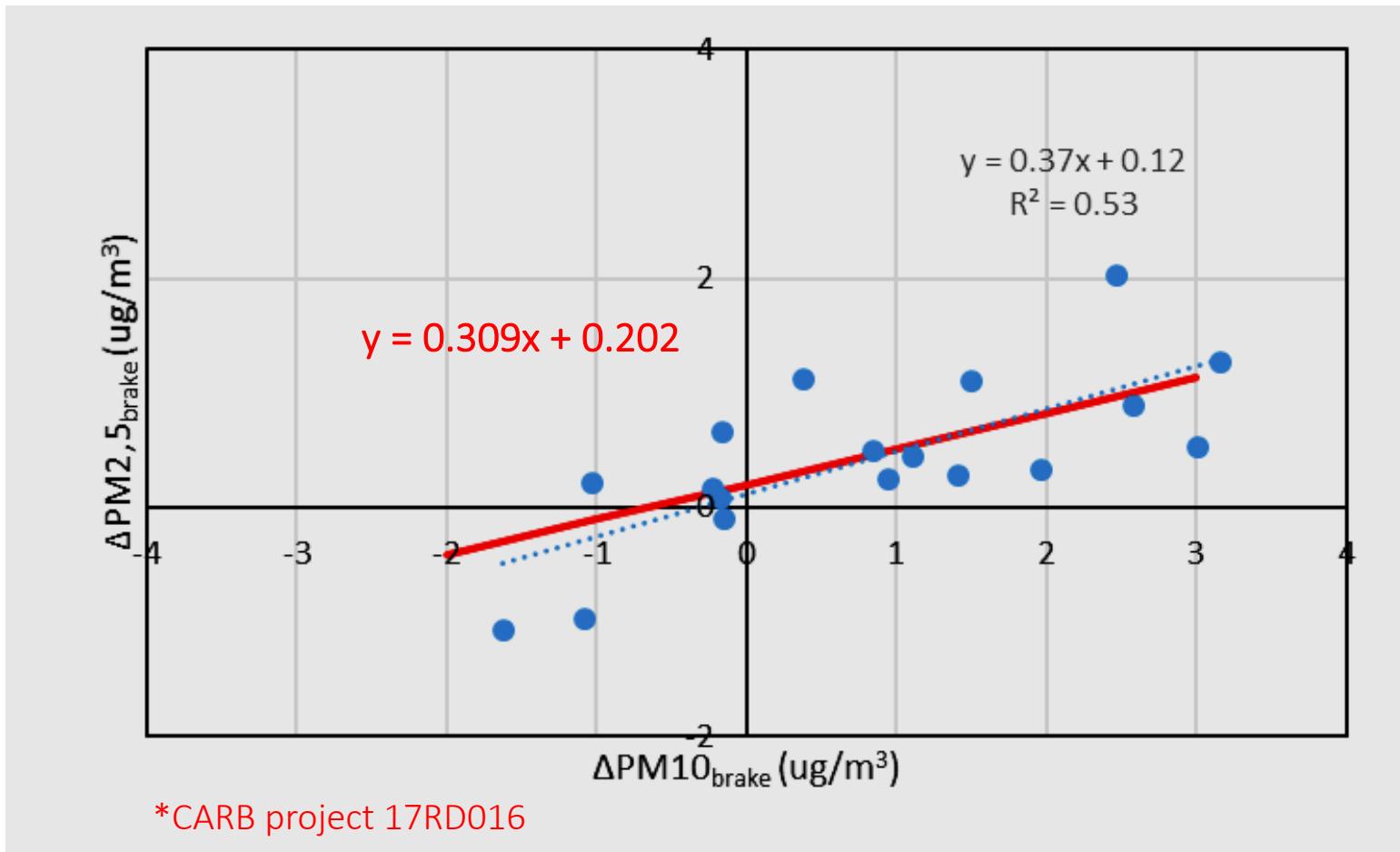
Typical sampling periods:

- 0600-1000
- 1000-1400
- 1400-1800

# Contribution of non-exhaust vehicle emissions to near-road PM<sub>2.5</sub> and PM<sub>10</sub>

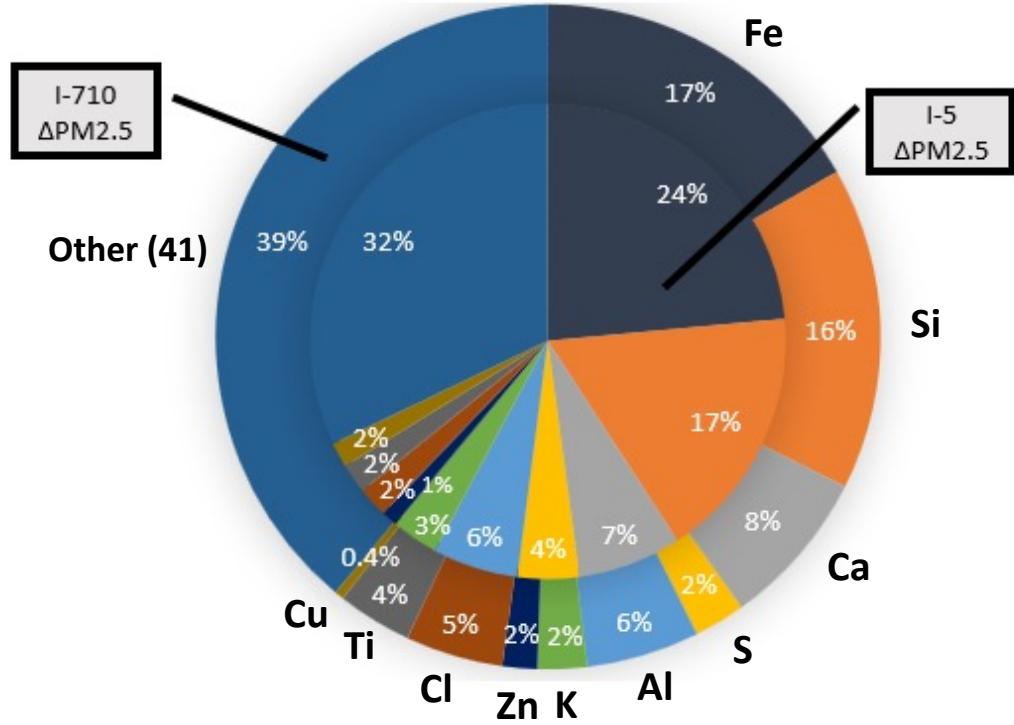


# Comparison between lab measured brake PM vs field-measured source- apportioned brake PM

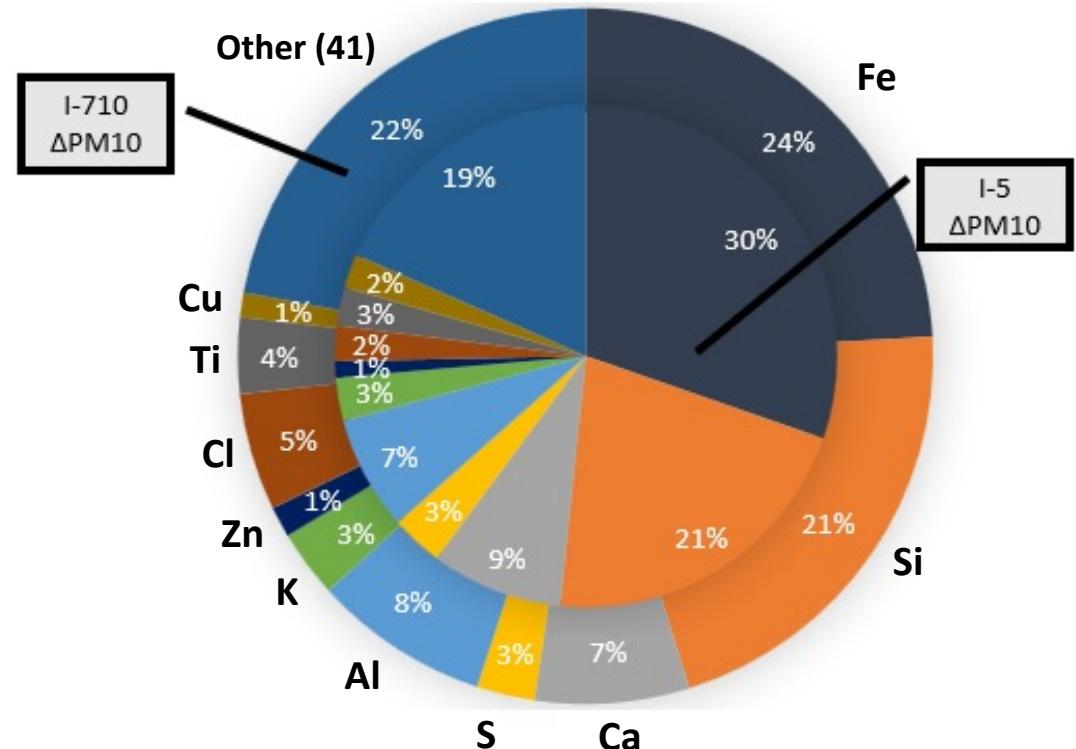


# Elemental Fractions

$\Delta\text{PM}_{2.5}$



$\Delta\text{PM}_{10}$



Elemental fractions of  $\Delta\text{PM}_{2.5}$  (left) and  $\Delta\text{PM}_{10}$  (right) at the I-5 highway location in Anaheim (inner) and the I-710 highway in Long Beach (outer).

# PM10 Elemental Correlations

- Dark green  $R^2 > 0.8$
- Light green  $R^2 = 0.6-0.8$
- Non-tailpipe markers:
  - Fe, Cu, Zr, Ti, Ba, Zn
  - Road dust: Al, Si, K, and Ca

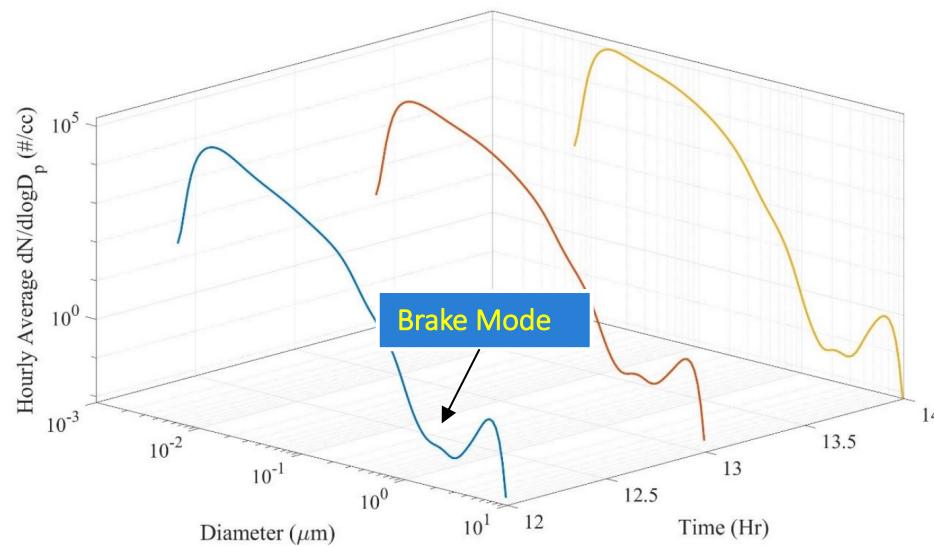
I-5 Anaheim ΔPM10

	Fe	Si	Ca	Al	K	Zn	Ti	Cu	Ba	Sb	Sr	Cr	Mn	Zr
Fe														
Si	0.31													
Ca	0.41	0.79												
Al	0.26	0.81	0.68											
K	0.56	0.33	0.22	0.24										
Zn	0.69	0.32	0.46	0.39	0.29									
Ti	0.90	0.27	0.30	0.21	0.49	0.70								
Cu	0.90	0.14	0.23	0.13	0.39	0.69	0.90							
Ba	0.69	0.07	0.17	0.07	0.32	0.63	0.76	0.80						
Sb	0.01	0.17	0.09	0.30	0.01	0.00	0.01	0.04	0.02					
Sr	0.53	0.22	0.23	0.12	0.27	0.38	0.43	0.46	0.28	0.00				
Cr	0.29	0.02	0.08	0.11	0.26	0.21	0.20	0.29	0.22	0.01	0.03			
Mn	0.67	0.25	0.34	0.12	0.43	0.26	0.48	0.49	0.26	0.07	0.50	0.08		
Zr	0.87	0.15	0.25	0.13	0.35	0.70	0.89	0.94	0.81	0.04	0.37	0.28	0.43	
Mo	0.01	0.03	0.01	0.00	0.01	0.01	0.01	0.06	0.00	0.02	0.00	0.25	0.00	0.04

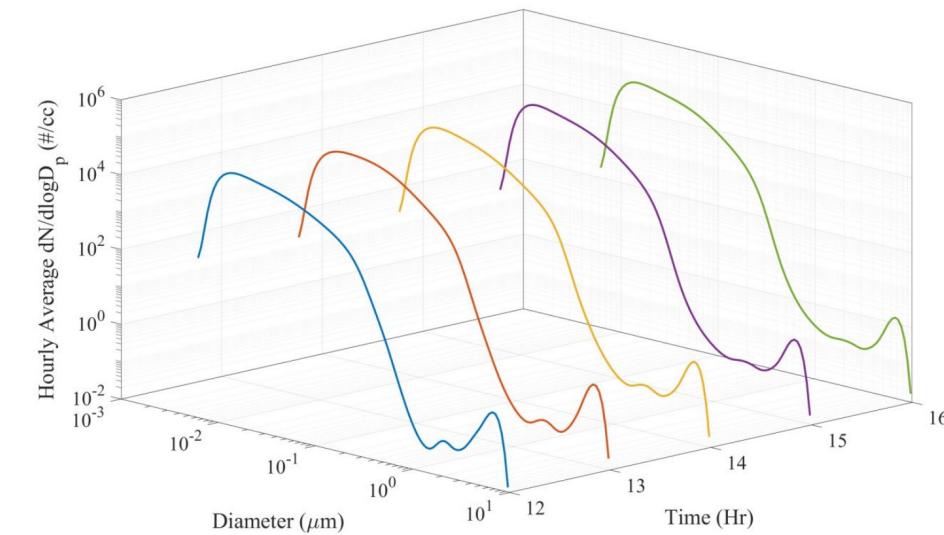
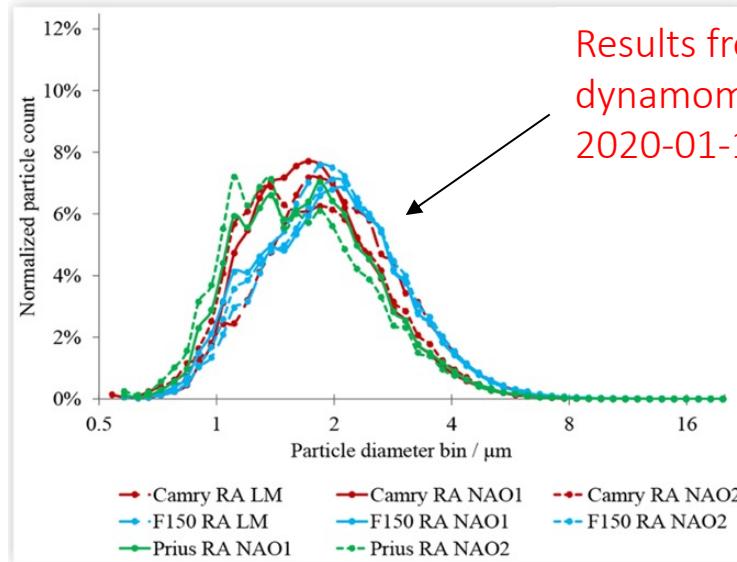
I-710 Long Beach ΔPM10

	Fe	Si	Ca	Al	K	Zn	Ti	Cu	Ba	Sb	Sr	Cr	Mn	Zr
Fe														
Si	0.40													
Ca	0.64	0.38												
Al	0.34	0.70	0.35											
K	0.46	0.94	0.32	0.61										
Zn	0.42	0.74	0.43	0.64	0.62									
Ti	0.08	0.20	0.39	0.49	0.10	0.38								
Cu	0.75	0.07	0.32	0.11	0.14	0.08	0.01							
Ba	0.44	0.03	0.38	0.10	0.04	0.11	0.15	0.40						
Sb	0.15	0.31	0.27	0.26	0.30	0.33	0.17	0.01	0.05					
Sr	0.19	0.07	0.35	0.13	0.04	0.11	0.22	0.12	0.01	0.14				
Cr	0.35	0.30	0.07	0.29	0.30	0.45	0.00	0.15	0.09	0.07	0.02			
Mn	0.37	0.38	0.23	0.29	0.34	0.24	0.05	0.14	0.17	0.19	0.00	0.09		
Zr	0.50	0.01	0.16	0.02	0.04	0.05	0.00	0.76	0.31	0.04	0.03	0.12	0.07	
Mo	0.01	0.10	0.02	0.13	0.09	0.07	0.01	0.01	0.03	0.23	0.07	0.17	0.30	0.05

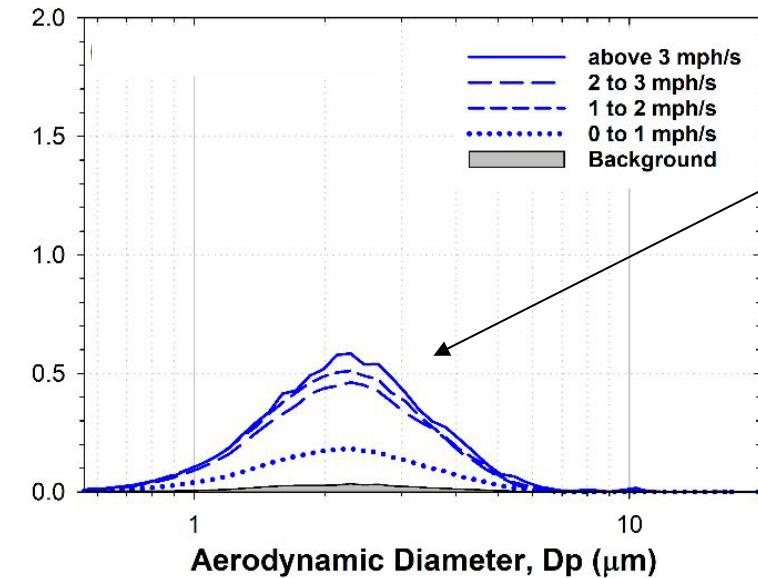
# Particle Size Distributions



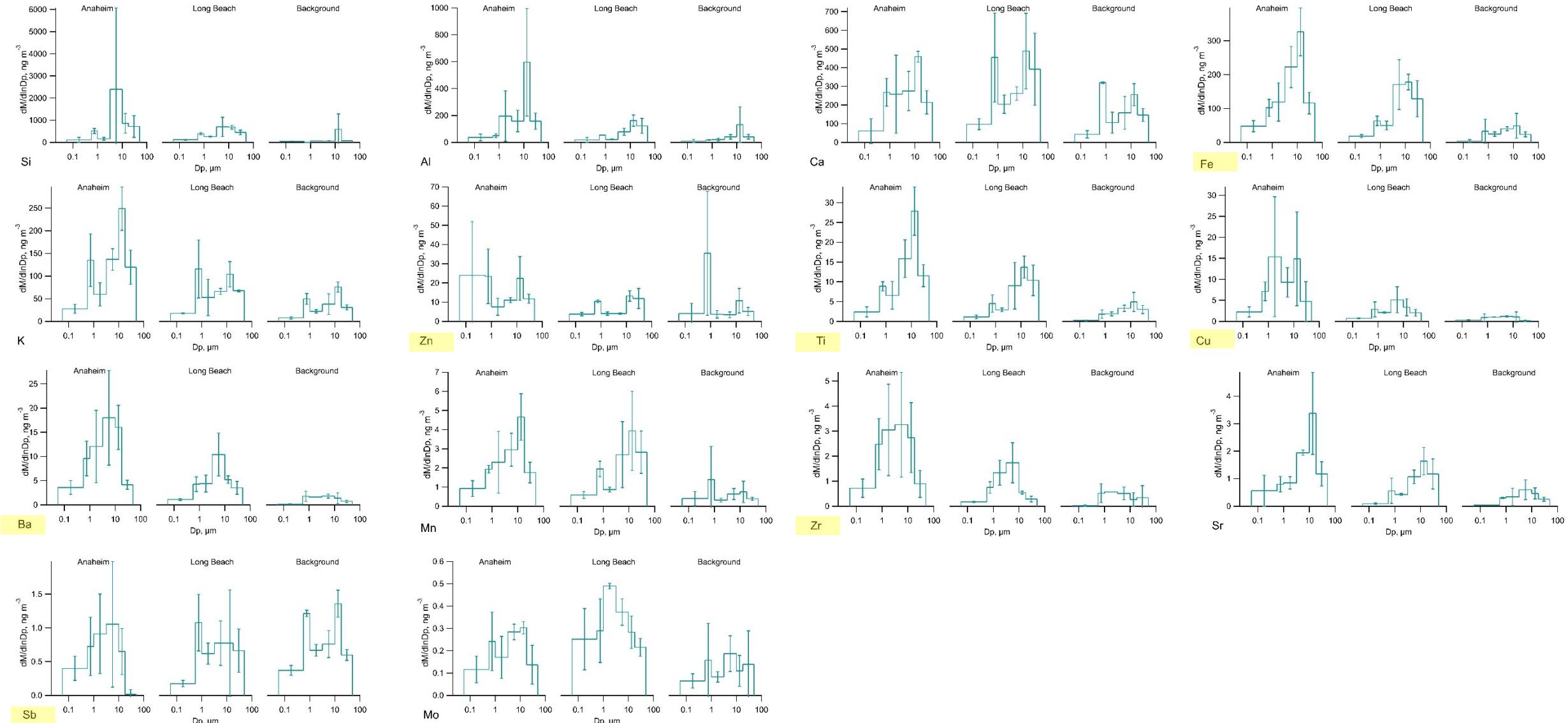
I-5 Anaheim – January 28th



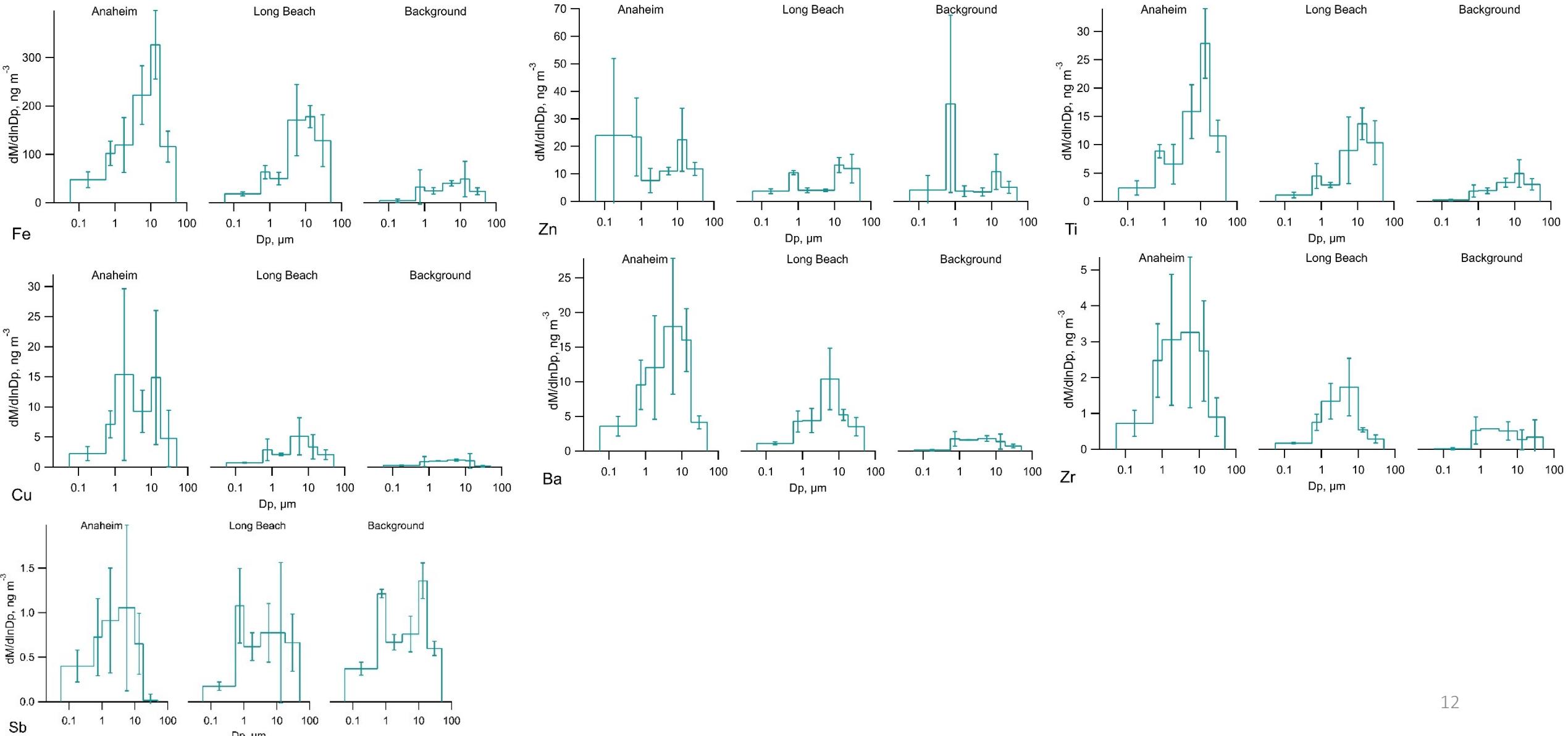
I-710 Long Beach – February 6th



# Size dependent chemical composition from MOUDI sample



# Size dependent chemical composition from MOUDI sample



# Summary

- Field measurements at near-road highways show non-tailpipe emission as much or more than tailpipe emissions.
- Particle size distribution and element mass distribution
  - metal elements from crust material and non-tailpipe emissions are present mostly above 1  $\mu\text{m}$  size.
- Brake markers (Ba, Sb) peaks between 1-10  $\mu\text{m}$  and tire markers (Zn) peaks 10-18  $\mu\text{m}$ .

# Acknowledgements

- SCAQMD staff for access to NR sites.
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# Q&A



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