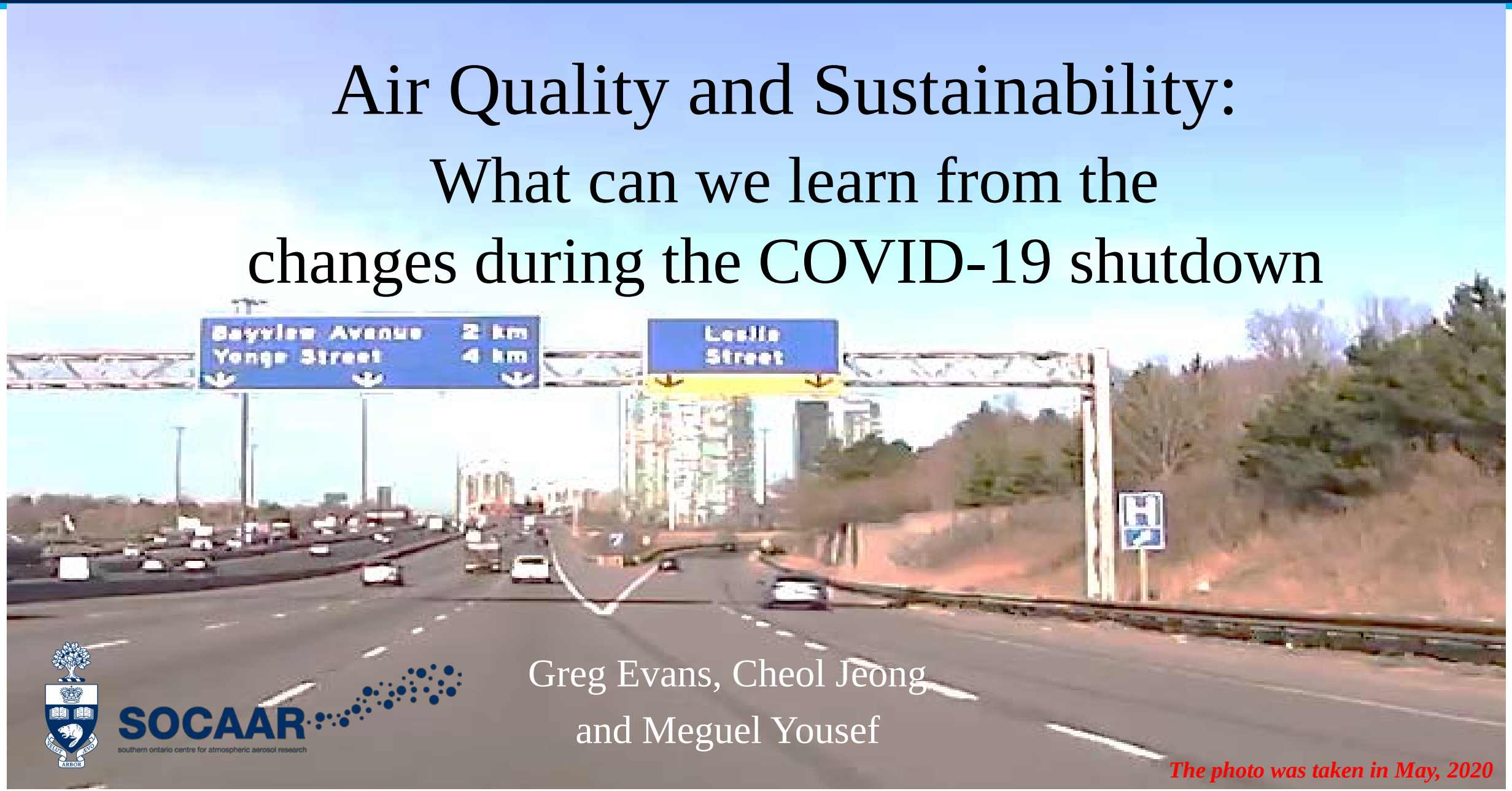
Air Quality and Sustainability:

What can we learn from the changes during the COVID-19 shutdown



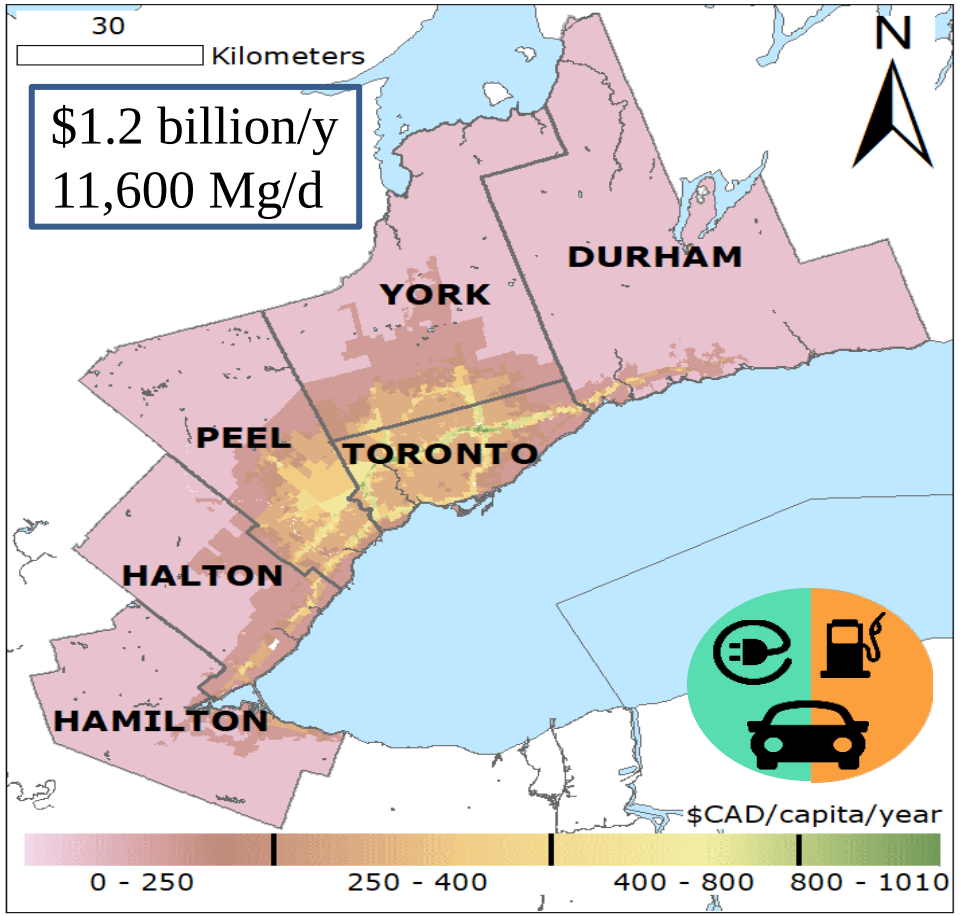
Greg Evans, Cheol Jeong
and Meguel Yousef

SOCAAR
southern ontario centre for atmospheric aerosol research

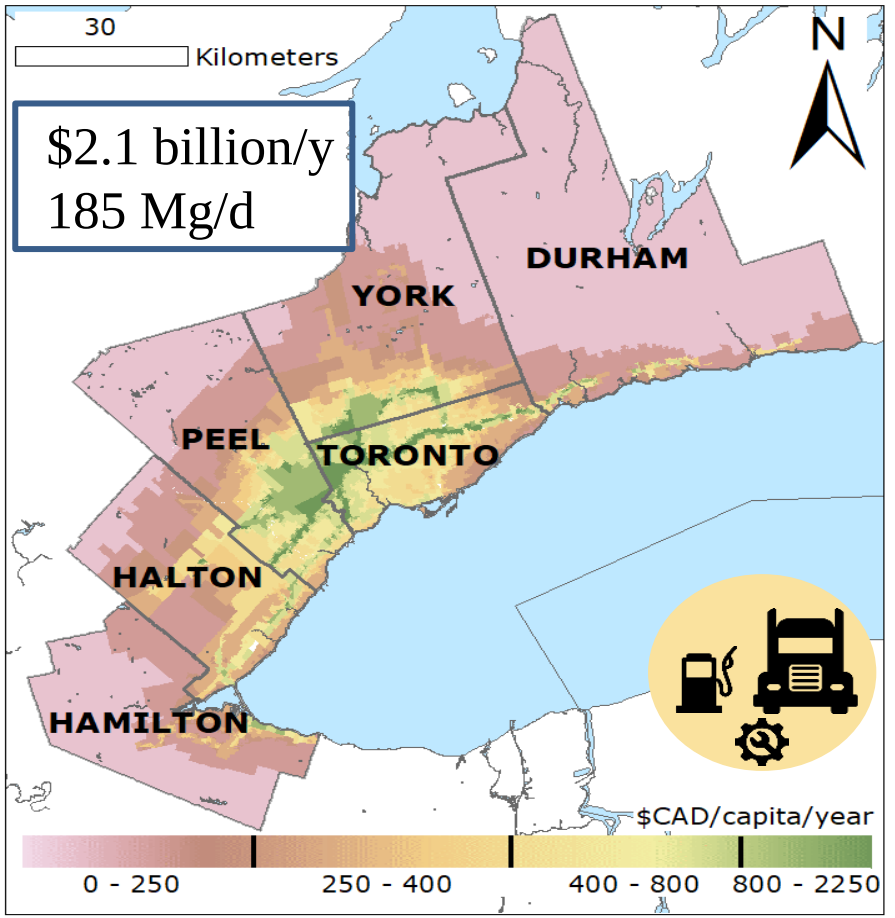
The photo was taken in May, 2020

Co-Benefits of Fleet Transformation[a]

Electrify 50% of cars



Replace old trucks



Social Benefits:
$10,000 per car replaced
$308,000 per truck replaced

Health Benefits: $/year GHG emissions saved: Mg CO_2 eq./day

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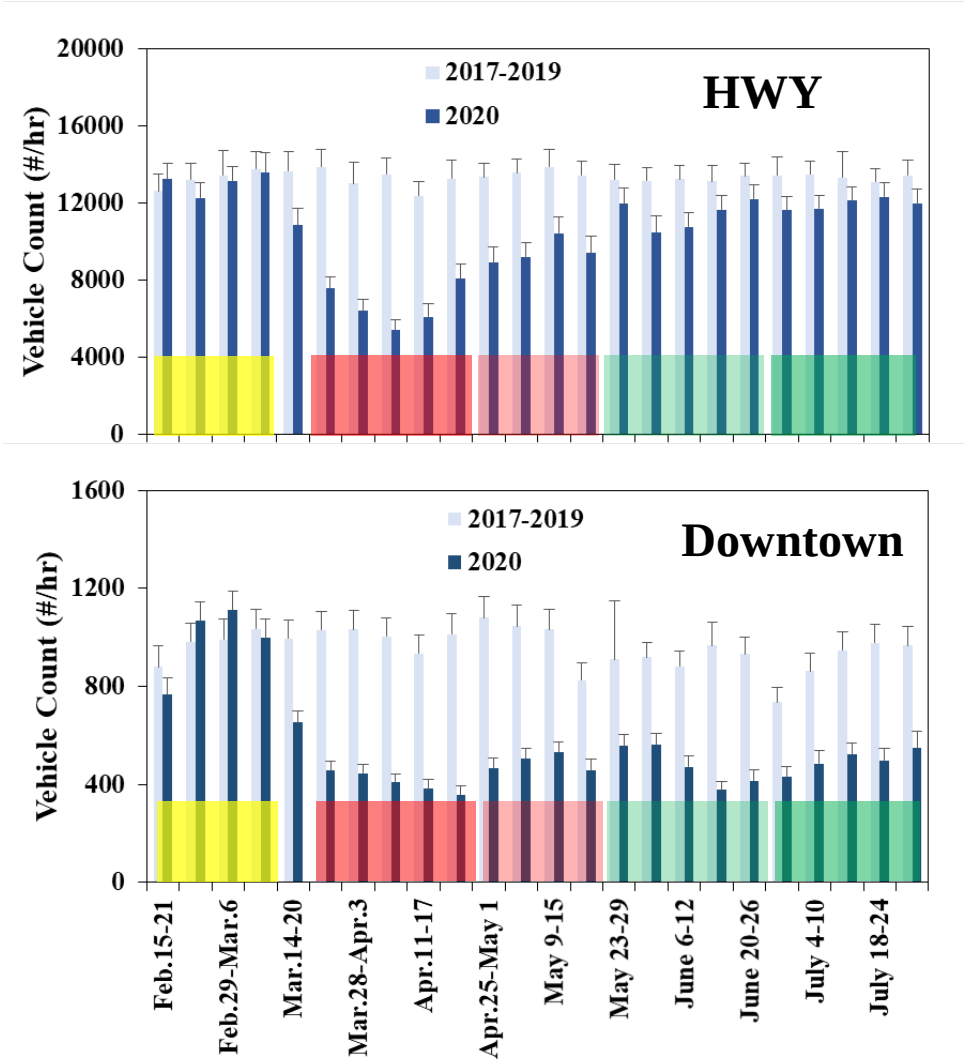
a: Laura Minet PhD Thesis 2020 and report

Change of Traffic Volume and Fleet Composition



Pre-Shutdown : Feb. 16 Mar. 14, 2020

Shutdown I: Mar. 22 – Apr. 25, 2020

Shutdown II : Apr. 26 – May 23, 2020

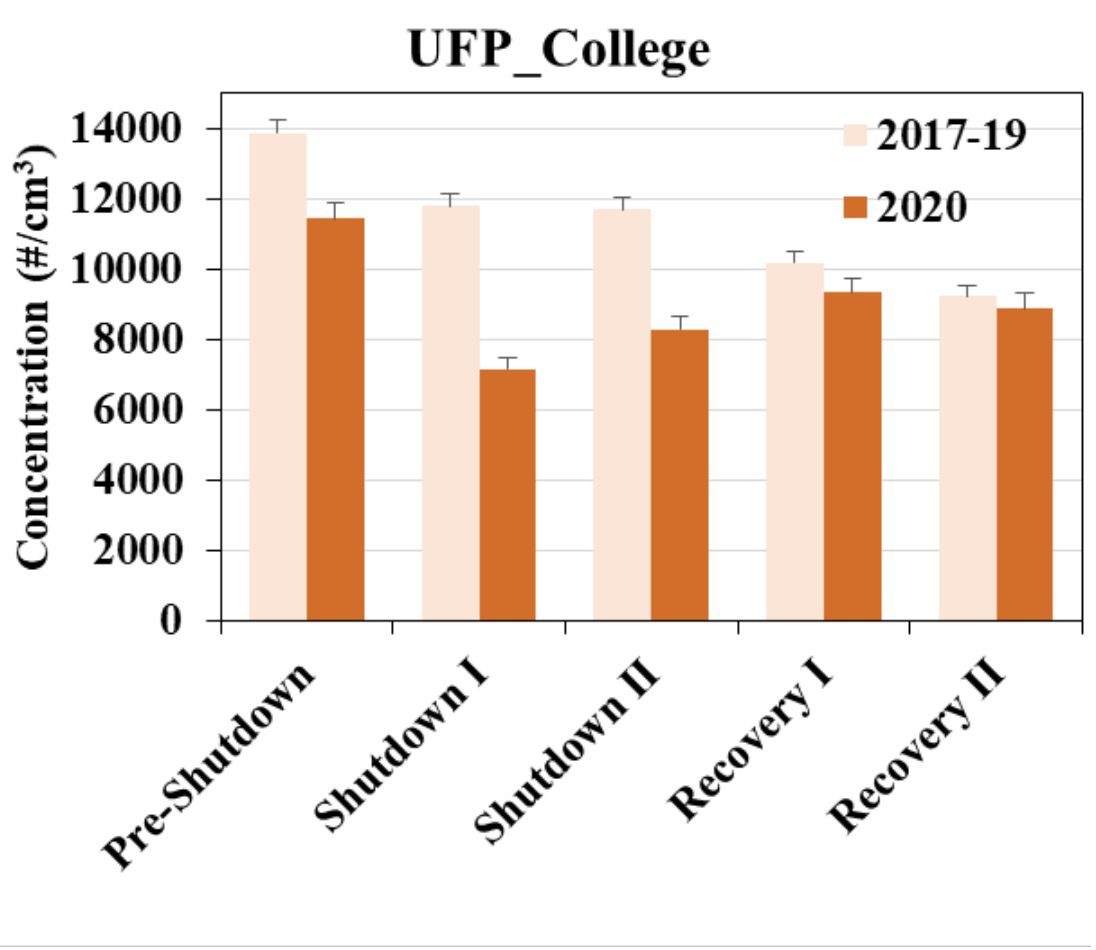
Recovery I : May 24 – June 27, 2020

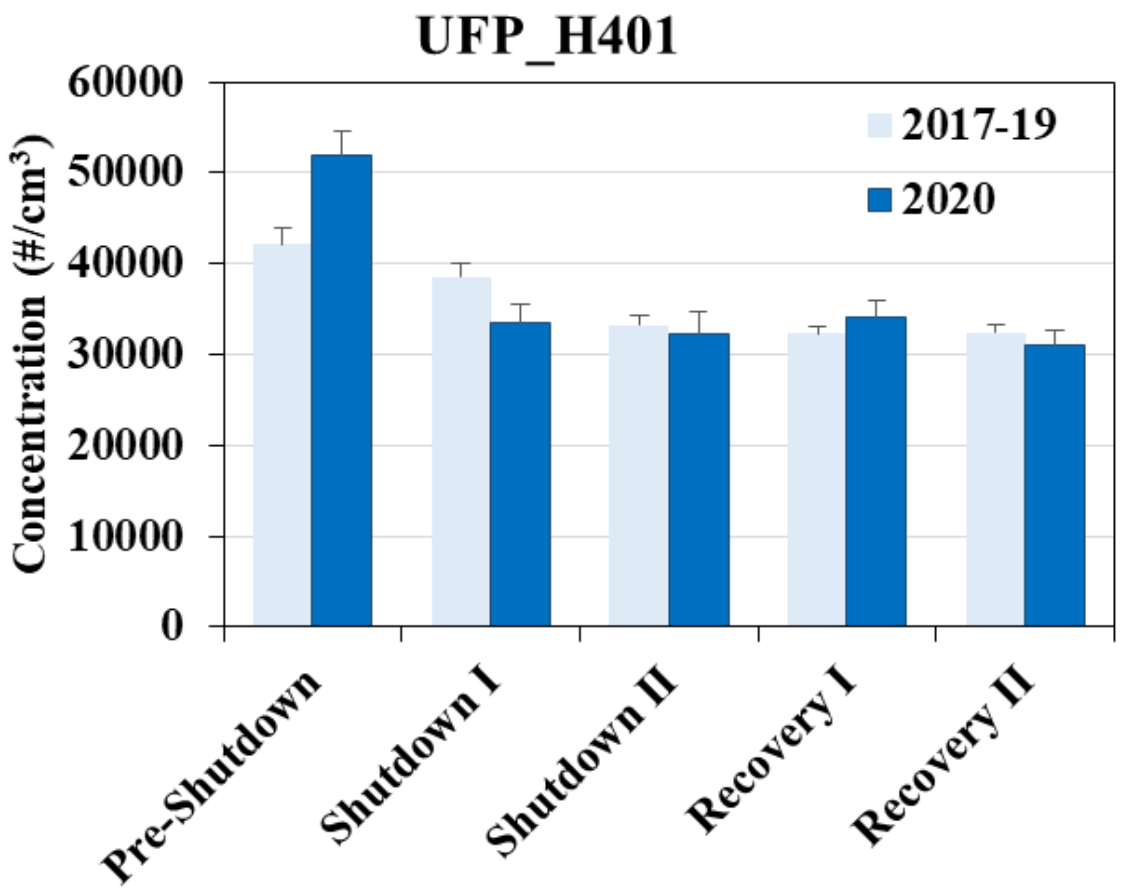
Recovery II : June 28 – July 25, 2020

Mean ± 95% CI

Change in Ultrafine Particles (UFP) in Toronto

Preliminary Data. Do not cite





Excess UFP Reduction: 26% (College) to 29% (401)

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Quantifying the reduction

Estimate the change of TRAPs and traffic patterns during the shutdown of the pandemic situation

- Comparing levels during shutdown to prior years or the month prior to shutdown in 2020 does not capture year-to-year of seasonal variability
- Need **Excess Reduction** (ER) : Compare the change during the same period for the last 3 years to estimate an excess change in 2020 due to the shutdown
- Can use difference in percentages or ratios:

$$\mathrm{ER} = \frac{Expexted - Measured}{Expected} = \left(\frac{\frac{Post2107-19}{Pre2017-19} \times Pre2020 - Post2020}{\frac{Post2107-19}{Pre2017-19} \times Pre2020} \right)$$

  - Pre-Shutdown: Feb. 16 - Mar. 14
  - Post-Shutdown: Mar. 22 - Apr. 25

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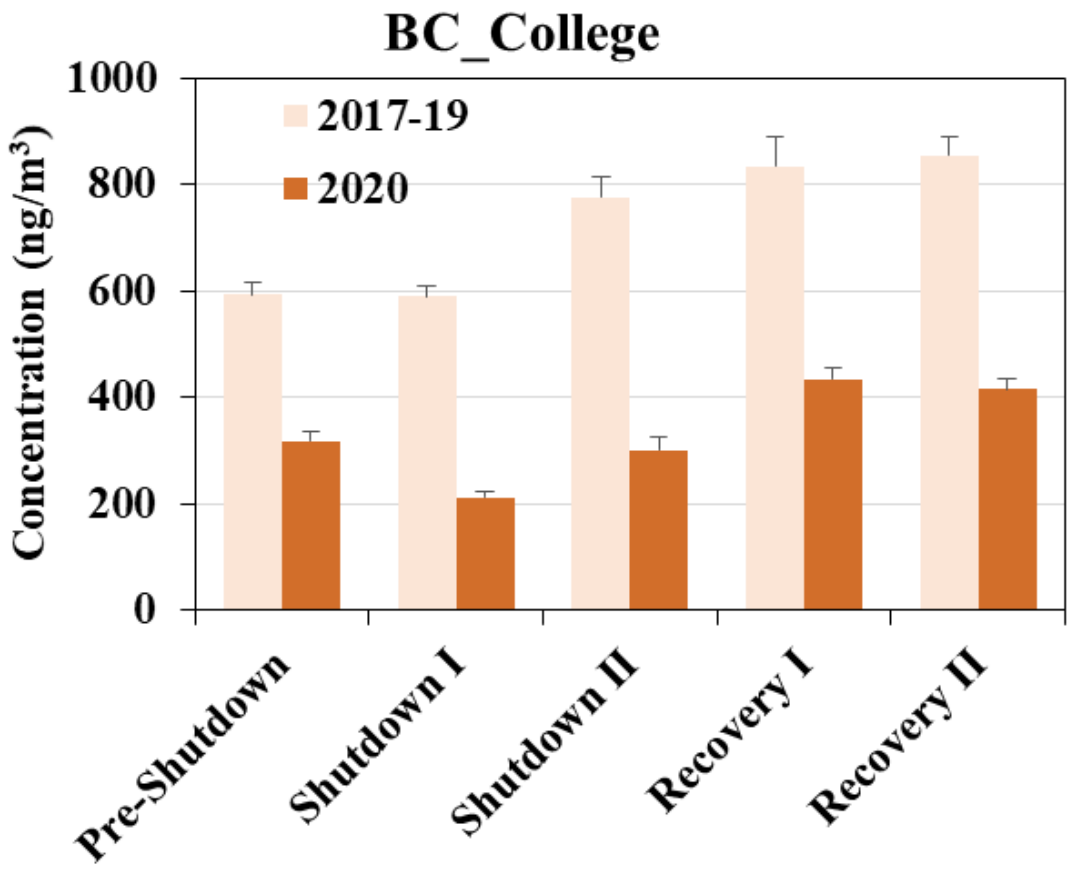
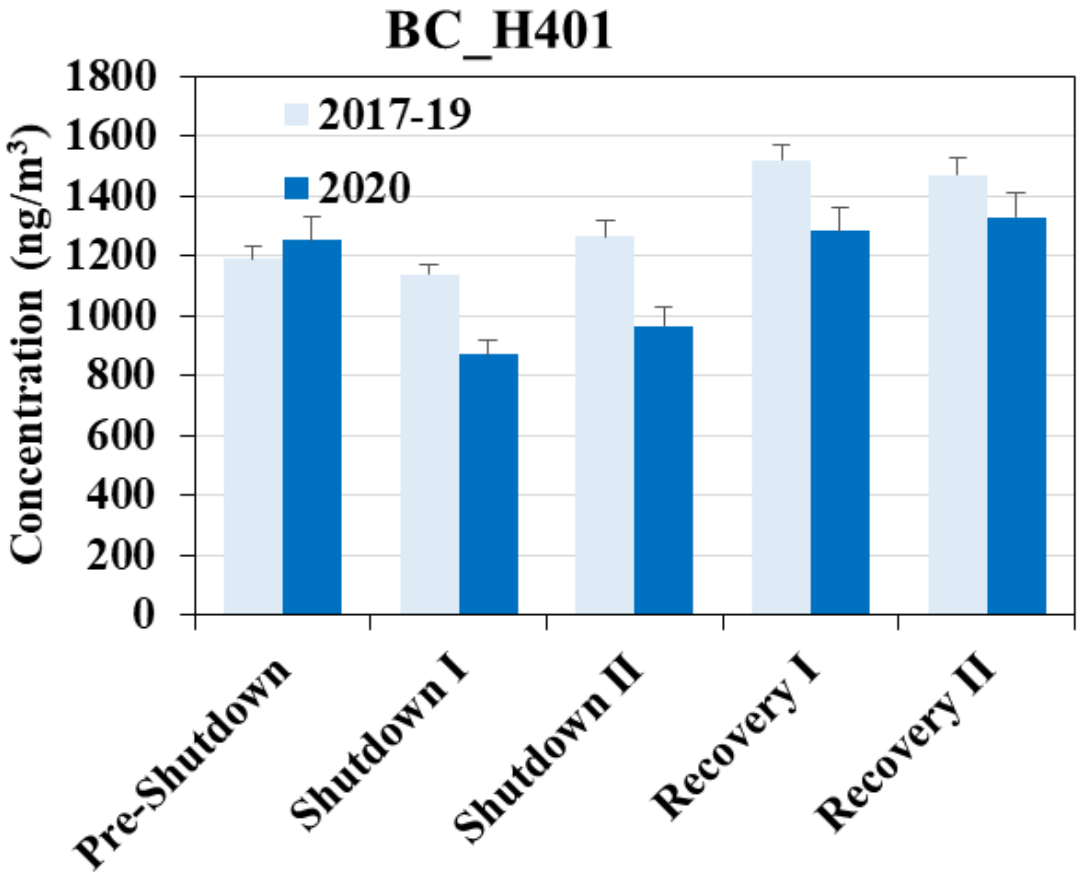
Change in Black Carbon (BC) in Toronto

Preliminary Data. Do not cite





Excess Black Carbon Reduction: 27% (401) to 33% (College)

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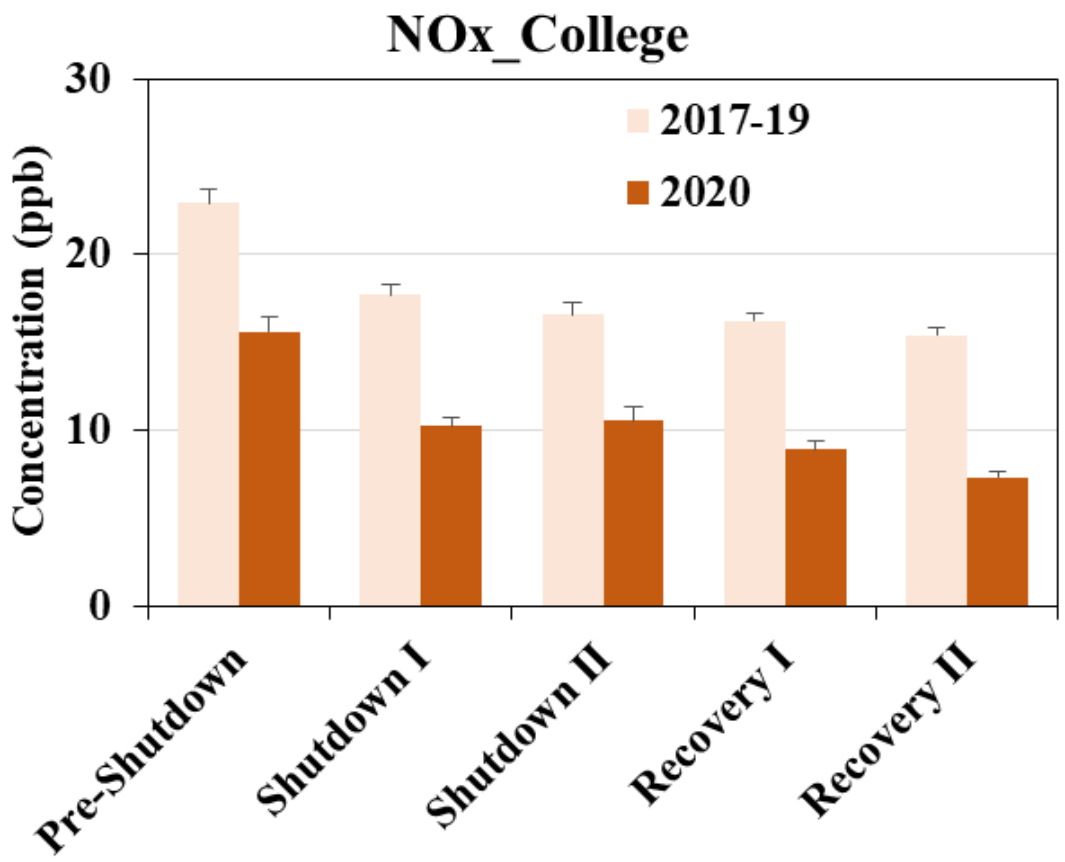
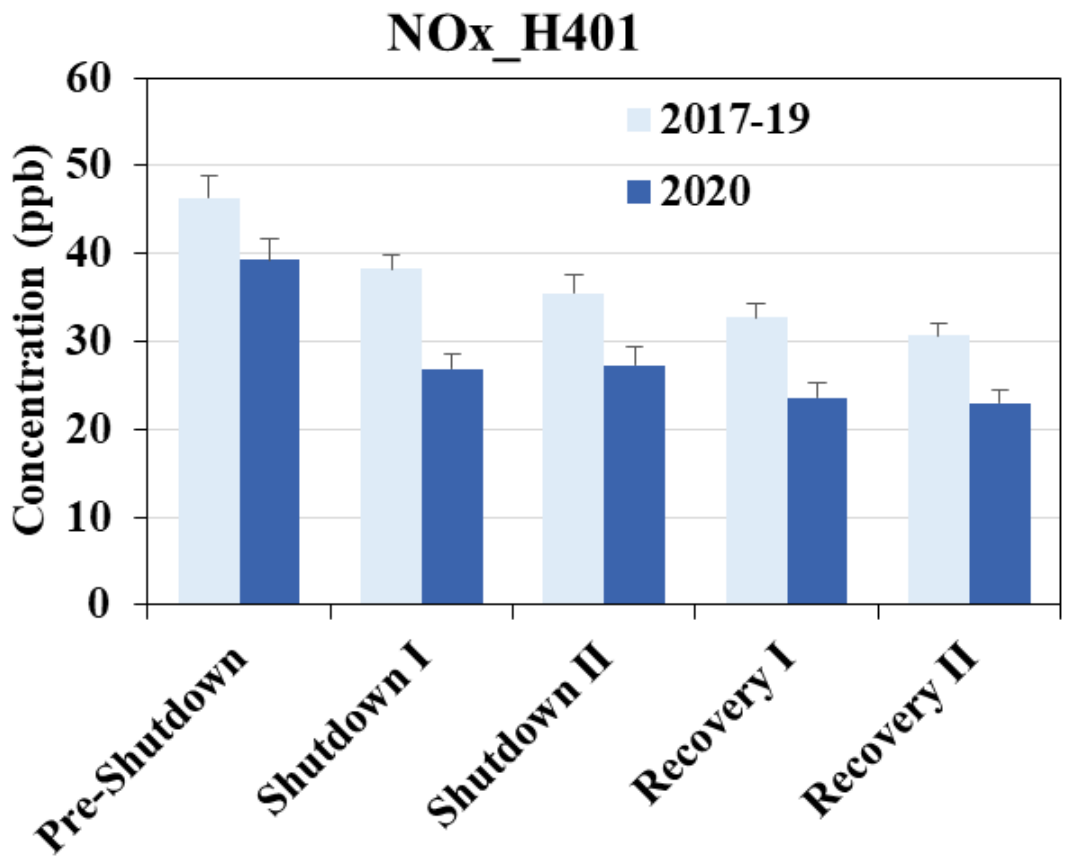
Change in Nitrogen Oxide (NOx) in Toronto

Preliminary Data. Do not cite





Excess NO_x Reduction: 15% (College) to 17% (401)

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Excess Reduction During the Shutdown

Preliminary Data. Do not cite

	Highway 401				College Street			
Ratios	UFP	BC	NOx	PM2.5	UFP	BC	NOx	PM2.5
Shutdown/pre in 2017-19	0.91	0.95	0.82	0.80	0.85	0.99	0.77	0.87
Shutdown/pre in 2020	0.64	0.69	0.68	0.81	0.63	0.69	0.66	0.79
Excess reduction in 2020	**29%**	**27%**	**17%**	**-1%**	**26%**	**33%**	**15%**	**9%**

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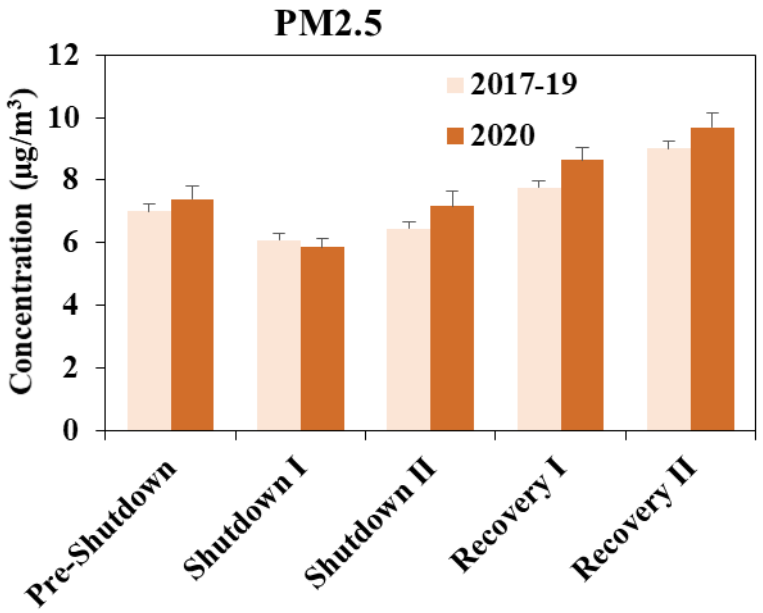
Small Reduction in PM2.5

Preliminary Data. Do not cite



Downtown	Excess Reduction
BC	33%*
UFP	26%
NOx	15%
PM2.5	9%

Lowest excess reduction during the lockdown period, why?

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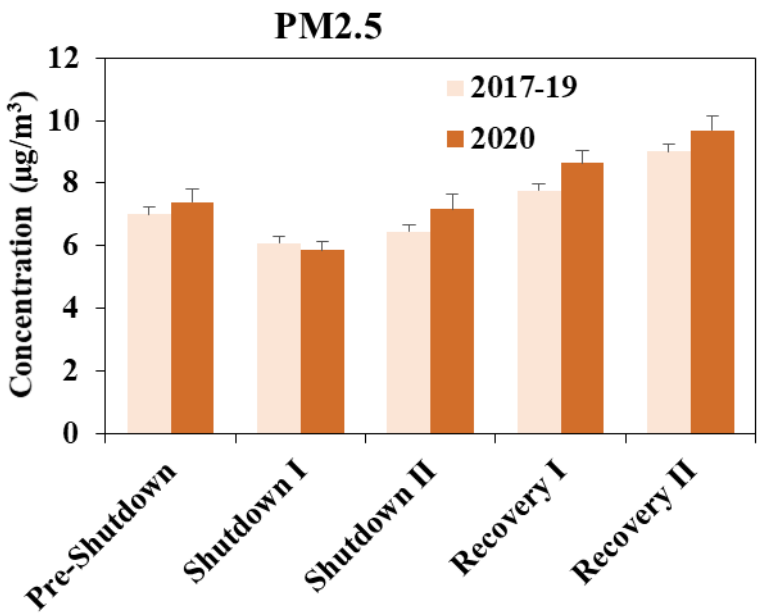
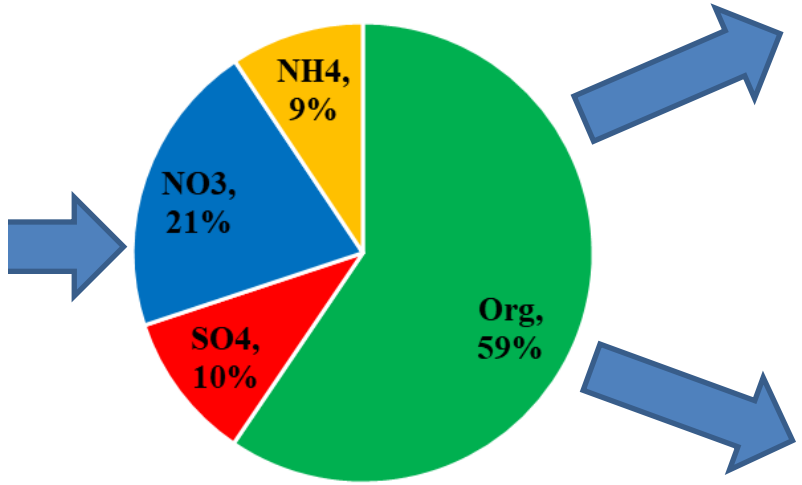
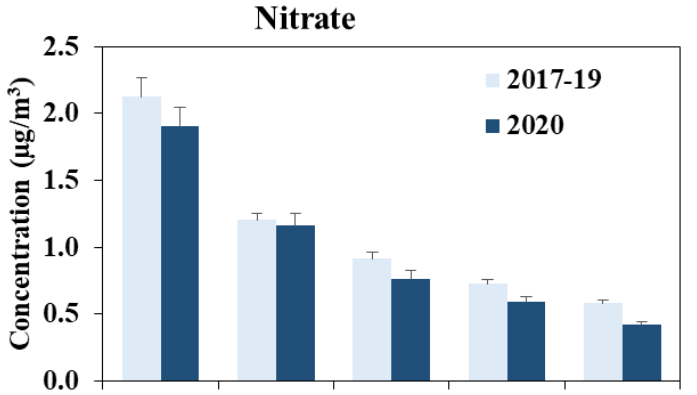
* Influenced by construction works

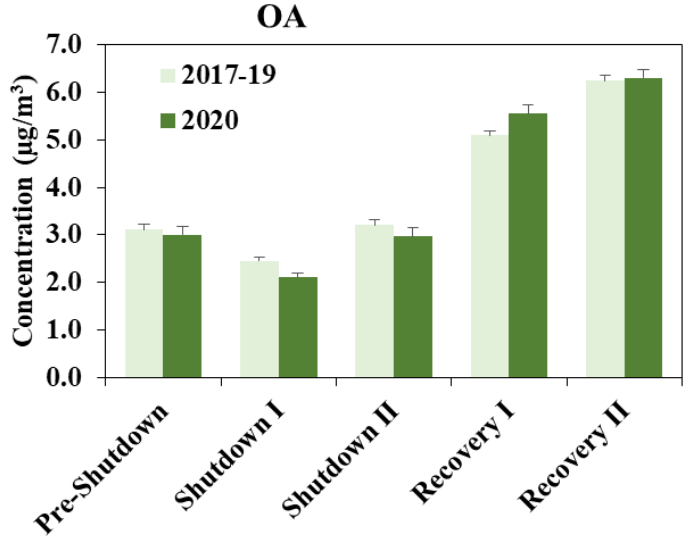
Change in PM2.5 Chemical Speciation

Preliminary Data. Do not cite





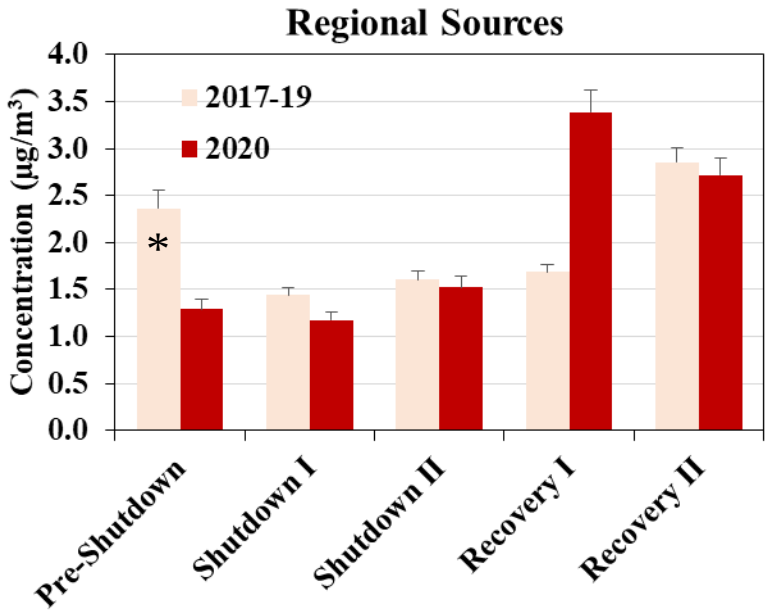


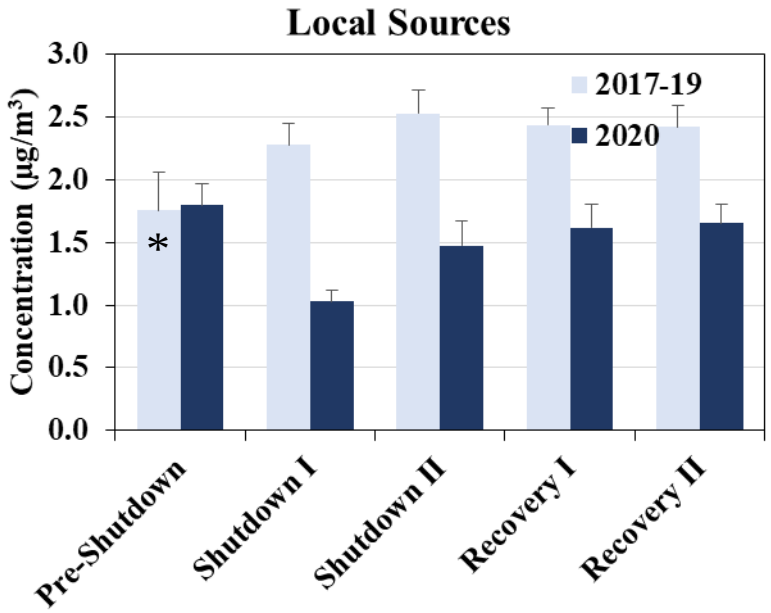


- PM2.5 is influenced by counter balanced regional and seasonal scale changes
- Identity the contributions of organic aerosol (OA) sources
- Consider subtle changes in local PM2.5 sources (i.e., traffic emissions)

Changes in Regional and Local PM2.5 Sources

Preliminary Data. Do not cite





Regional (Aged OA+Coal Combustion)
No Excess Reduction

Local (Cooking+TE+NTE+Metal)
Excess Reduction: 56%↓

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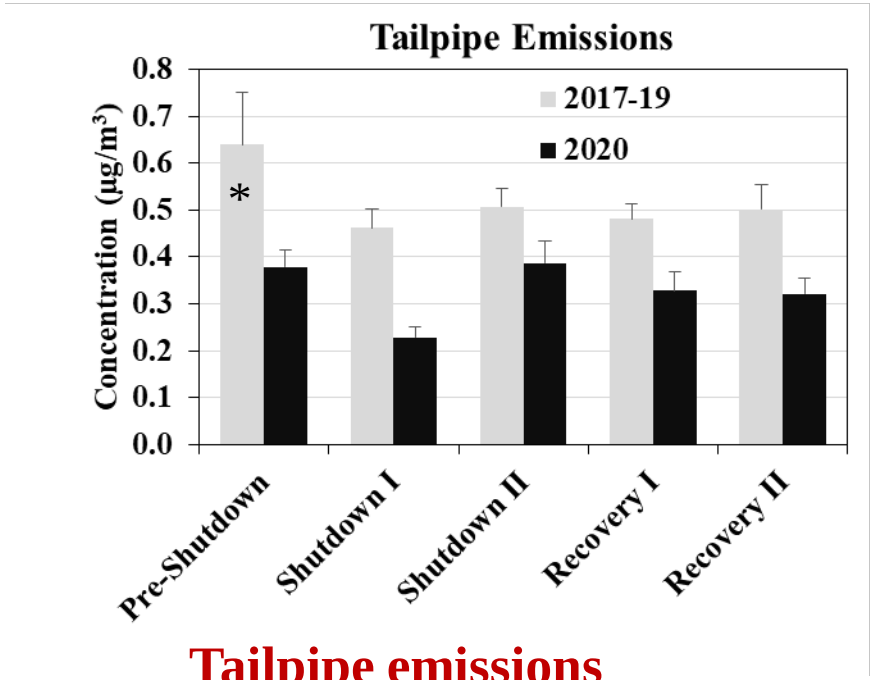
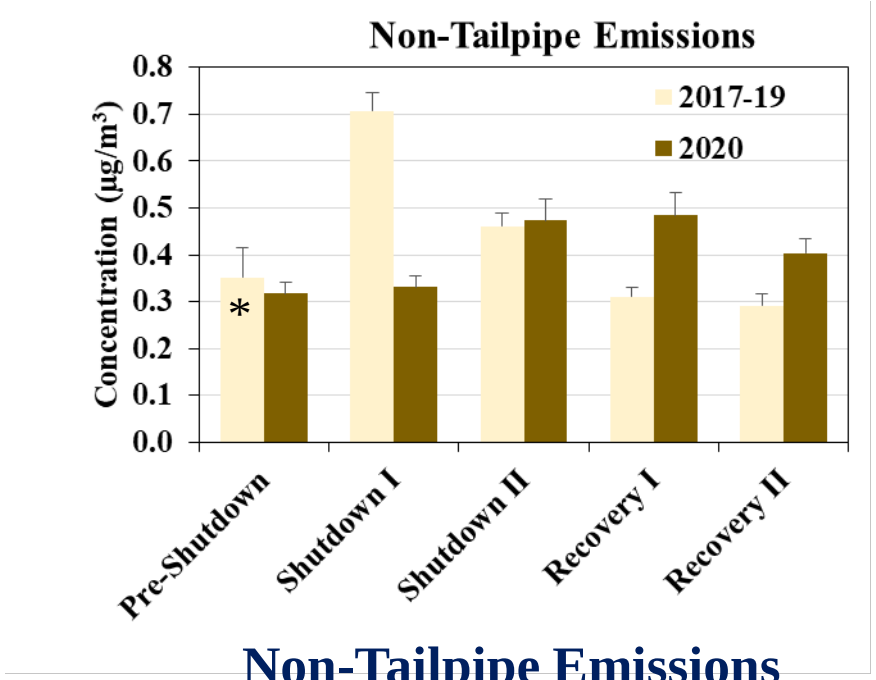
** 90% of missing data in 2017-2019*

Changes in Tailpipe vs. Non-Tailpipe PM2.5 Sources

Preliminary Data. Do not cite



Tailpipe emissions
Excess Reduction: 16%↓



Non-Tailpipe Emissions
Excess Reduction: 48%↓

Disproportional reduction in traffic-relates sources possibly due to
the changes in fleet composition, meteorological condition, and construction works

** 90% of missing data in 2017-2019*

In summary

- The COVID-19 shutdown had a substantial impact on air quality that varied across pollutants and locations.
- The more subtle change in PM2.5 from vehicles, cooking, and road dusts was found through more comprehensive analysis
- Equivalent long-term reductions could yield substantial savings through social benefits
- Do we have adequate capabilities to measure these air quality benefits?

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