Setting the Framework for Aviation Air Quality Studies during the COVID-19 Pandemic

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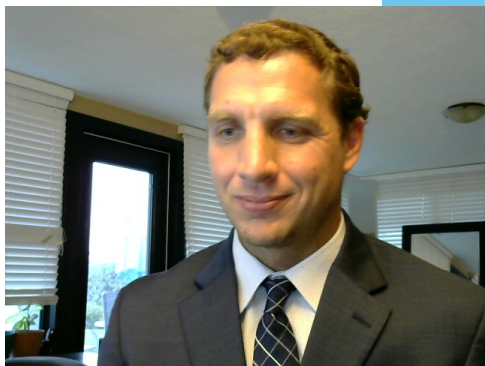
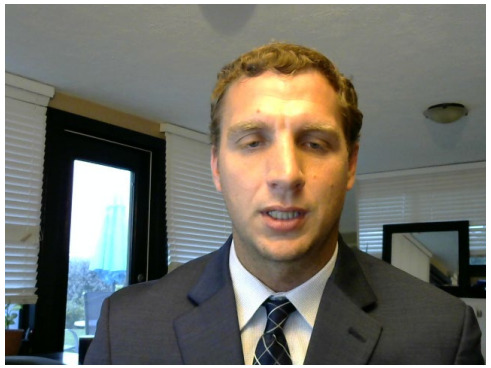


About Me

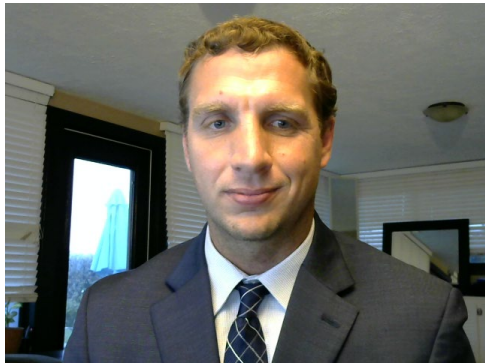
Robbie Gross, Ph.D.

- Air Quality Scientist
  - Crawford, Murphy, & Tilly (CMT)
  - Formerly KB Environmental Sciences (KBE)
- Ph.D. Environmental Engineering
  - University of Florida
  - Air quality focus area
- Specialize in aviation air quality.



Considerations

1	COVID-19 Impacts on Aircraft Operational Levels
2	Motor Vehicle Traffic Changes
3	Pollutant Characteristics
4	Pollutant Focuses: Ozone, Ultrafine Particles (UFPs)
5	Meteorology
6	Monitoring
7	Statistical Analyses



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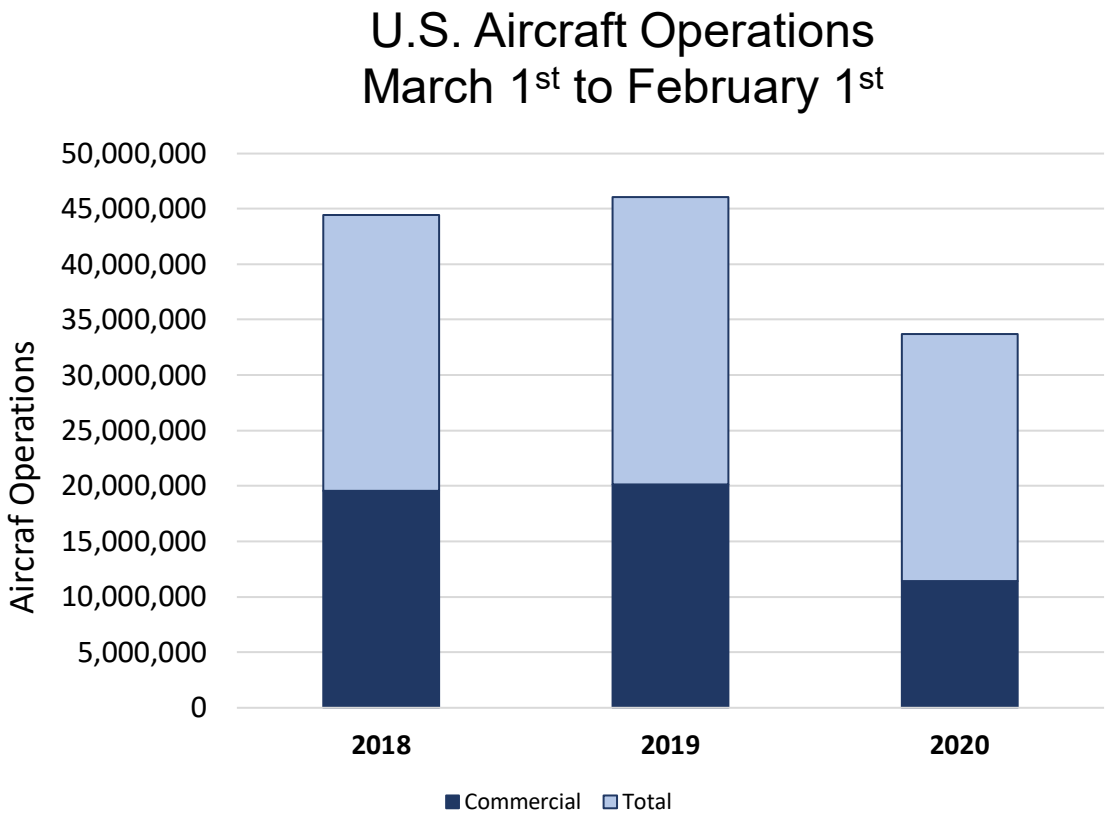
COVID-19 Impacts on Aviation

- 2018 to 2019 showed slight increase
- 2020 Global passenger reductions
  - ICAO estimates = **-60%**
- U.S. Operations
  - Mar. 1st to Feb. 1st 2019 vs 2020
  - Total Operations Change = **-27%**
  - Commercial Operations = **-43%**
  - Non-commercial = **-14%**

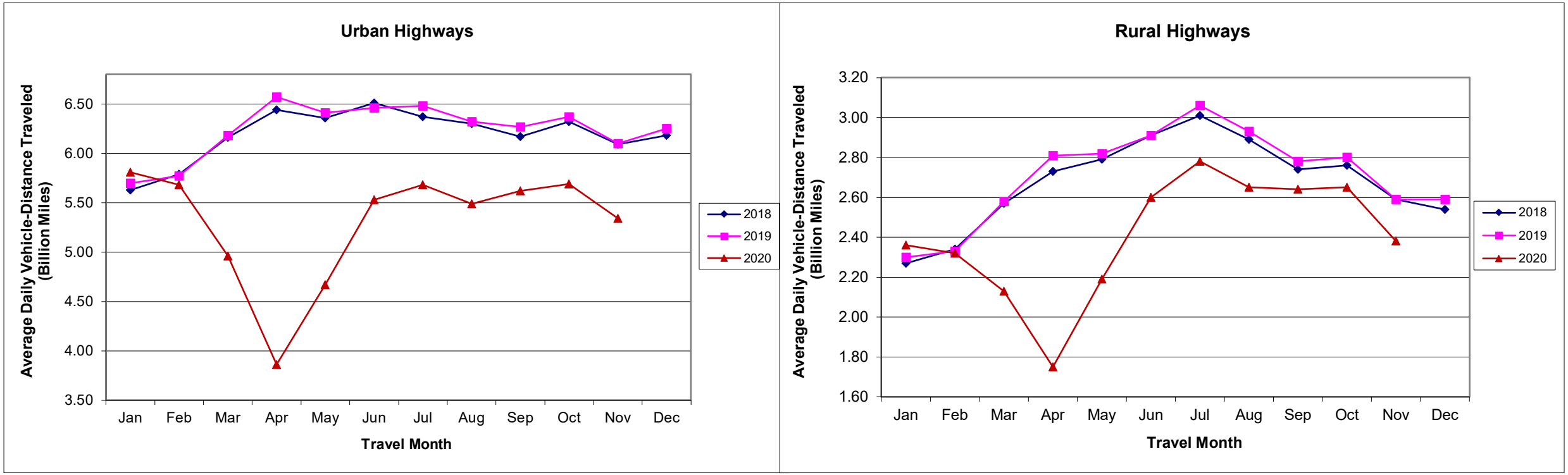


Note: Commercial operations = air carrier + air taxi

Source: Federal Aviation Administration Operations Network (OPSNET)

Motor Vehicle Traffic Changes

Travel on U.S. Highways by Month



Source: U.S. Federal Highway Administration
https://www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm

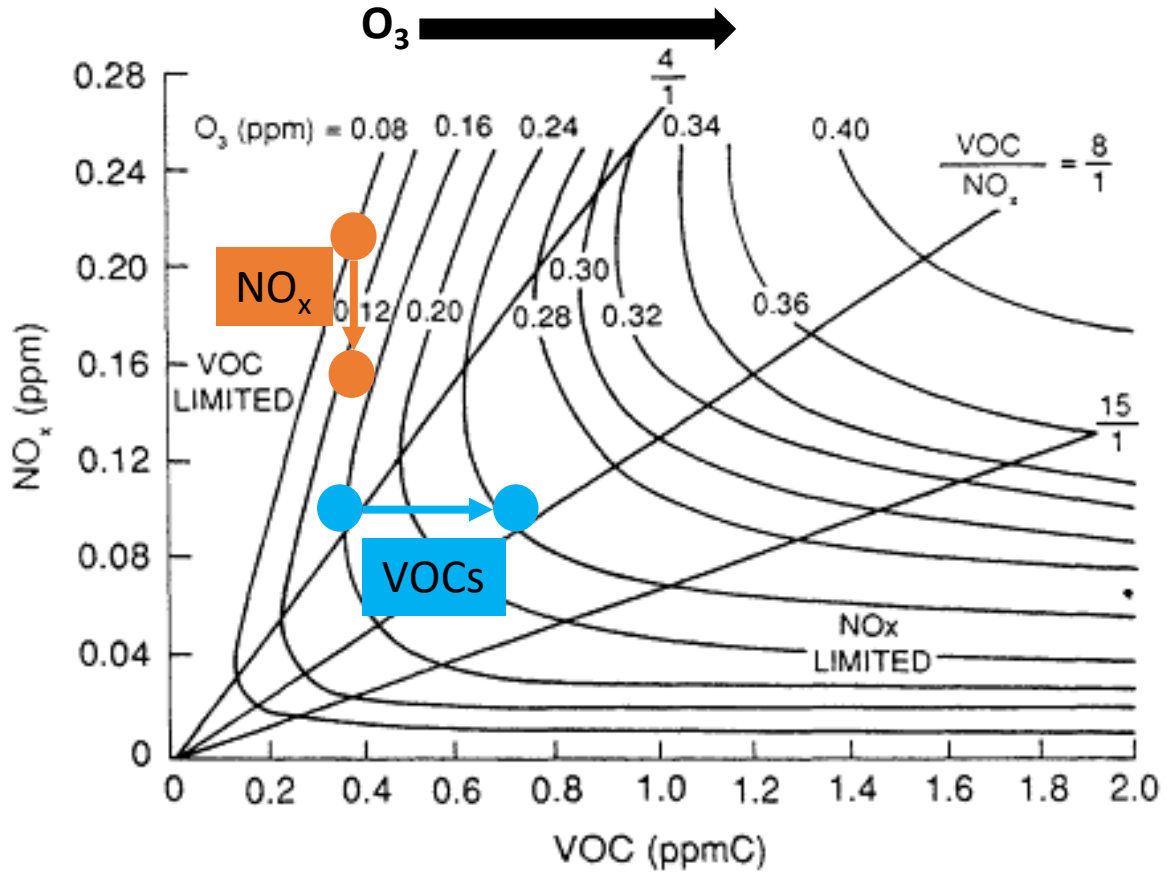
Pollutant Characteristics

Pollutants		Primary/Secondary Pollutant	Atmospheric Lifetime	Reactivity	Health Impact Averaging Timeframes
Carbon Monoxide (CO)		Primary	1-2 months	High	8 hours
					1 hour
Nitrogen Dioxide (NO_2)		Primary	1-2 weeks	High	1 hour
					1 year
Sulfur Dioxide (SO_2)		Primary	1-2 weeks	Moderate	1 hour
					3 hours
Ozone (O_3)		Secondary	2-4 weeks	High	8 hours
Particulate Matter	$PM_{2.5}$	Both	Days to weeks	Low to High	1 year
					24 hours
	PM_{10}	Primary	Hours	Low	24 hours

Note: NAAQS = National Ambient Air Quality Standards.
Source: U.S. EPA: ttps://www.epa.gov/criteria-air-pollutants/naaqs-table.

Ozone Formation

- Forms mainly from NO_x and VOCs
- NO_x and VOC contributions depend on the type of environment
- Urban areas ➔VOC limited
- Rural areas ➔NO_x limited



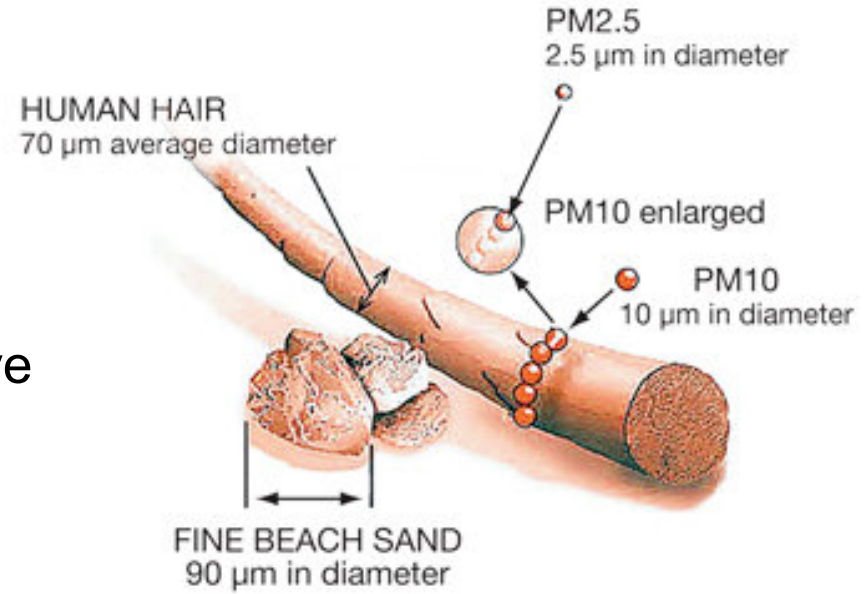
Sources: https://www3.epa.gov/ttnecas1/regdata/RIAs/2-ozoneriachapter2.pdf
https://www.nap.edu/read/1889/chapter/8#165

Ultrafine Particles (UFPs)

- Particulates with diameters less than 0.1 microns
- Motor vehicles and aircraft are both sources

  Motor vehicles ➔ Larger UFPs

  Aviation ➔ Smaller UFPs
- UFPs dissipate rapidly with distance from source and are sensitive to meteorological factors
- Studies have shown that sites downwind of airports have higher UFPs
- **The question**: What is the impact of operational changes?



µm is 1 micron which equals 1 millionth of a meter

Source: https://www.ptleader.com/stories/ultrafine-particles-sharp-contrast-of-opinions,48598

Sources: University of Washington, Mobile ObserVations of Ultrafine Particles: The MOV-UP study report, December 2019, https://deohs.washington.edu/mov-up.
Hudda N, Simon MC, Zamore W, Brugge D, Durant JL. Aviation Emissions Impact Ambient Ultrafine Particle Concentrations in the Greater Boston Area. *Environ Sci Technol*. 2016;50(16):8514-8521. doi:10.1021/acs.est.6b01815

Meteorology

Meteorology has a substantial impact on air quality

Cold Weather	→	More particulates, UFPs
Hot Weather	→	More ozone formation
Strong Wind	→	Lower pollutant concentrations
Calm Wind	→	Higher pollutant concentrations

Monitoring Locations

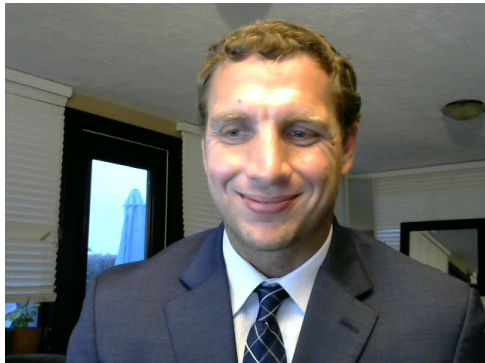
- On-airport may not reflect community air quality conditions.
- Both on-airport and community monitor locations should be utilized.
- There are very few airports with ongoing air quality monitoring programs.

Statistical Analysis

- Correlation does not imply causation!
- Still, statistical significance is necessary to rule out random chance and coincidence.
- Correlations should not be used to imply a relationship without statistical significance.

Summary

- COVID-19 reduced aircraft operations, mainly commercial.
- Motor vehicle traffic rebounded quickly compared to aircraft.
- Pollutants have a range of different behaviors and health impact timeframes.
- Ozone formation varies by region ➔ NO_x vs. VOC limited.
- UFP size is related to source types ➔ aircraft = smaller, motor vehicles = larger
- Meteorology needs to be considered to understand how pollutants behave.
- Airport and community monitor sites are needed.
- Statistical analysis is needed to determine significance.



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Thank you

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