Ultrafine Particle and Black Carbon Monitoring at T.F. Green Airport

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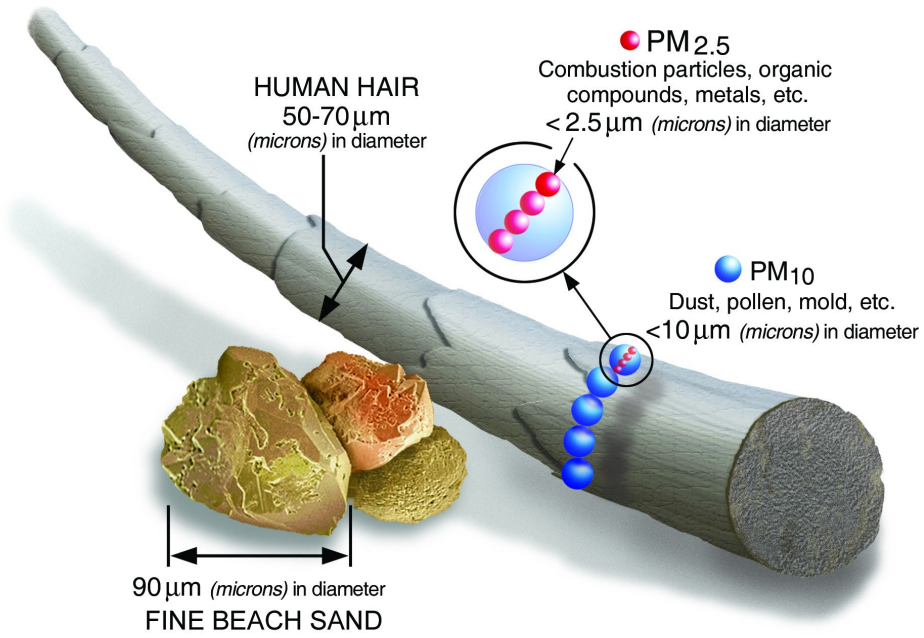
Introduction

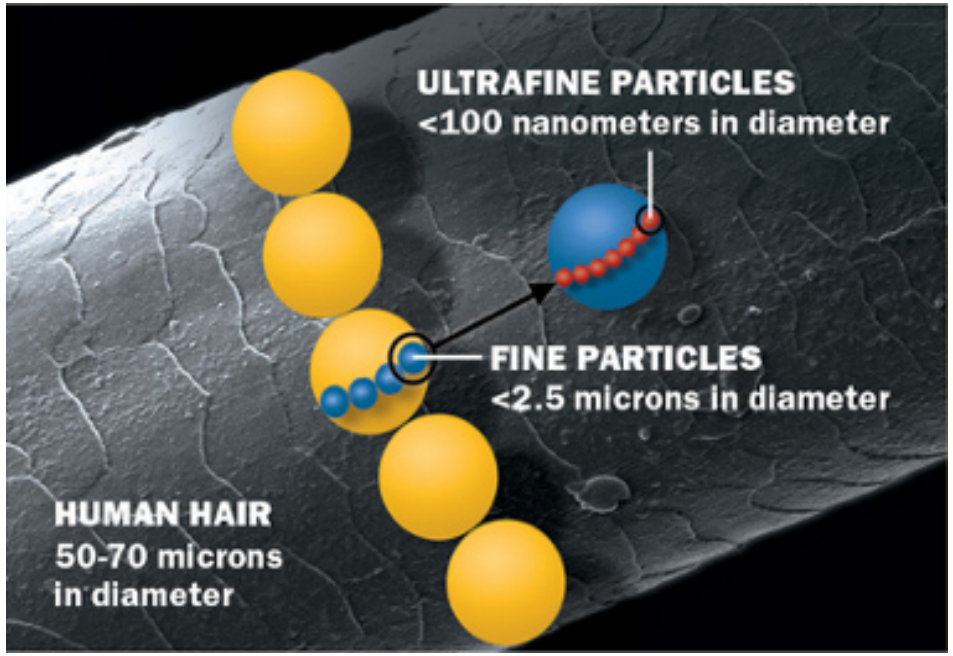
- **Particulate Matter (PM)** - a mixture of solid particles and liquid droplets in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope.
- **PM_{10}** - inhalable particles with diameters that are generally 10 micrometers and smaller.
- **$PM_{2.5}$** - inhalable particles with diameters that are generally 2.5 micrometers and smaller.
- **Ultrafine Particles** - particles with diameters that are generally 0.1 micrometers and smaller.
- **Black Carbon** – a component of $PM_{2.5}$ (about 12%) formed by the incomplete combustion of fossil fuels, biofuels, and biomass.



Source: U.S. EPA https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM.

Ultrafine Particles (UFPs)

- Multiple sources and factors impact UFP concentrations and atmospheric behavior.
- Measured by count, not mass.
- Urban background concentrations of UFPs range from 5,000 - 40,000 particles/$cm^{3.}$
- Decrease rapidly from the source (~50% every 150 meters) ➔ UFP behavior and tendencies are highly localized.
- The largest source of UFPs are motor vehicles, and aircraft also contribute.
- Recent studies have demonstrated different characteristics between aircraft and motor vehicle emitted UFPs.
- Aircraft UFPs are smaller (10-20 nm) than motor vehicle UFPs (~65 nm) ➔ not often detected by UFP monitors.



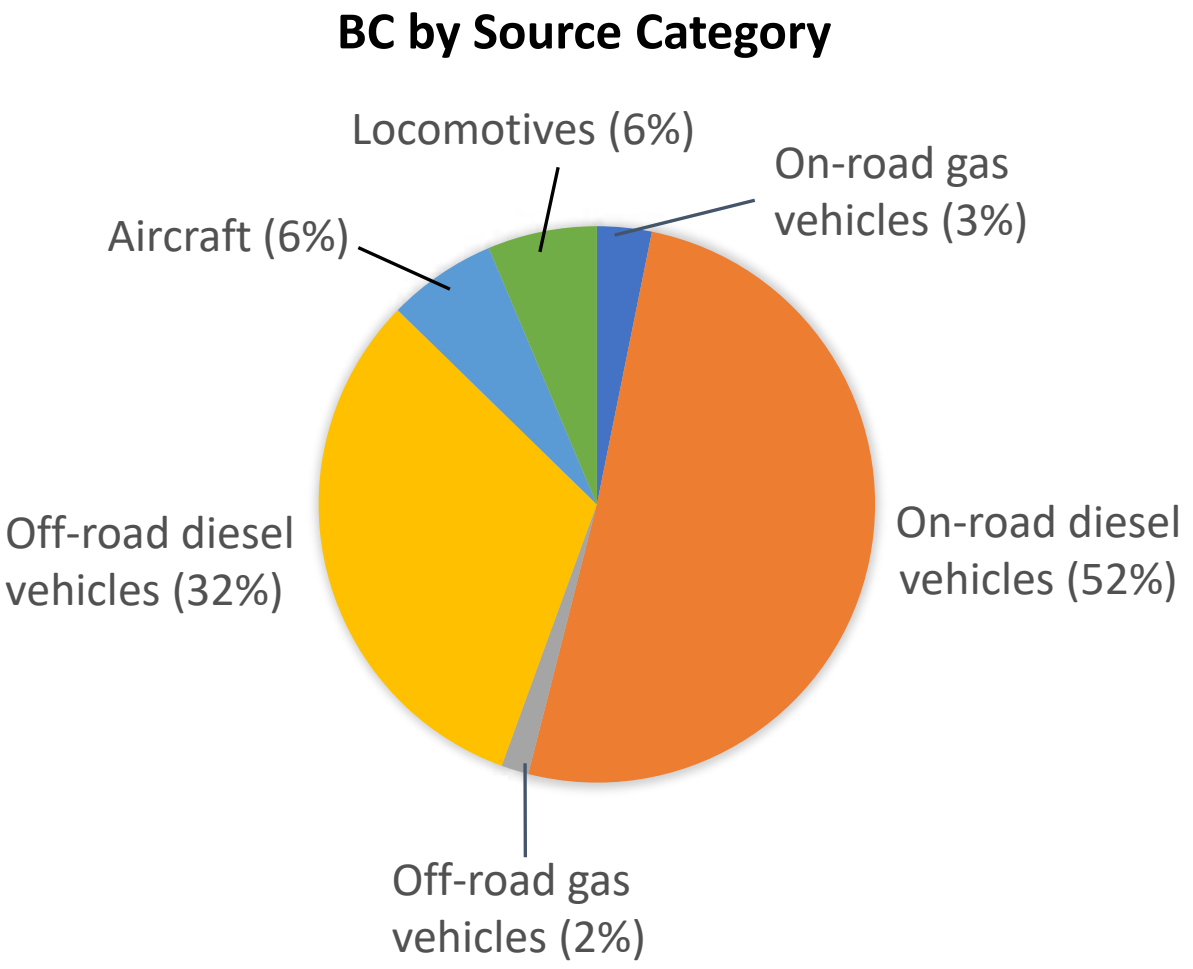
Sources:
University of Washington Mobile ObserVations
of Ultrafine Particles: December 2019 The MOV-UP study report
https://deohs.washington.edu/sites/default/files/Mov-Up%20Report.pdf
Tufts University, https://now.tufts.edu/articles/big-road-blues-pollution-highways

Black Carbon (BC)

BC impacts global climate and public health.

BC impacts are local to regional.

- Climate:
  - BC is a strong light-absorber
  - Can absorb a million times more energy than carbon dioxide (CO_2).
- Public Health:
  - short- and long-term exposures associated with health impacts
  - respiratory and cardiovascular effects



Source: U.S. EPA https://www3.epa.gov/airquality/blackcarbon/basic.html.

Potential Health Impacts

Ultrafine Particles

- Due to their small size UFPs can easily penetrate the pulmonary alveoli in the lungs causing respiratory health issues.
- However, “Although many studies have identified health effects associated with roadway traffic UFP counts, the potential health effects from aircraft-related UFP exposure still needs major research.”

Black Carbon

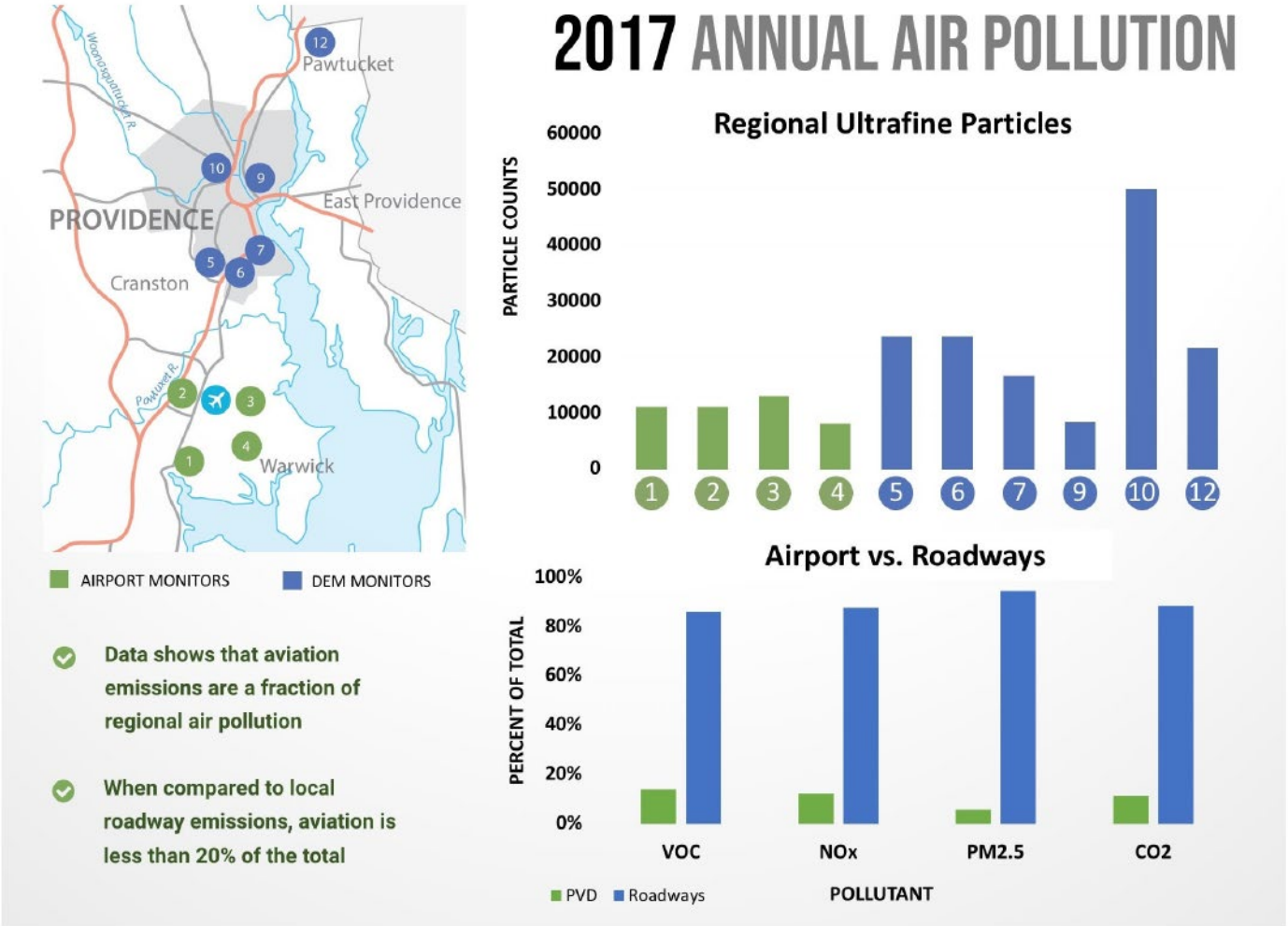
- Research is increasingly trying to identify the health impacts of $PM_{2.5}$ components, such as BC.
- There is insufficient information to differentiate the health effects of these components.
- U.S. EPA assumes that many components are associated with adverse health impacts.
- Limited scientific research suggests evidence for cardiovascular effects.

Sources: Moreno-Ríos, et al., Sources, characteristics, toxicity, and control of ultrafine particles: An overview, Geoscience Frontiers, 2020, https://doi.org/10.1016/j.gsf.2021.101147.
U.S. EPA, https://www3.epa.gov/airquality/blackcarbon/effects.html.

Regulatory Framework

- The U.S. EPA has set National Ambient Air Quality Standards (NAAQS) for six "criteria air pollutants"
  - Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Ozone (O_3), Lead (PB), and PM.
  - PM NAAQS are for PM_{10} and $PM_{2.5}$.
- NAAQS were determined through extensive scientific research demonstrating that exposure to these pollutants in exceedance of these standards can be harmful to human health and the environment.
- Currently, there are **no NAAQS for UFPs or BCs**, meaning there are no federally accepted standards by which to measure impacts of monitored UFP or BC on human health.

RIAC vs. Other Regional Emission Sources and Air Quality Monitors



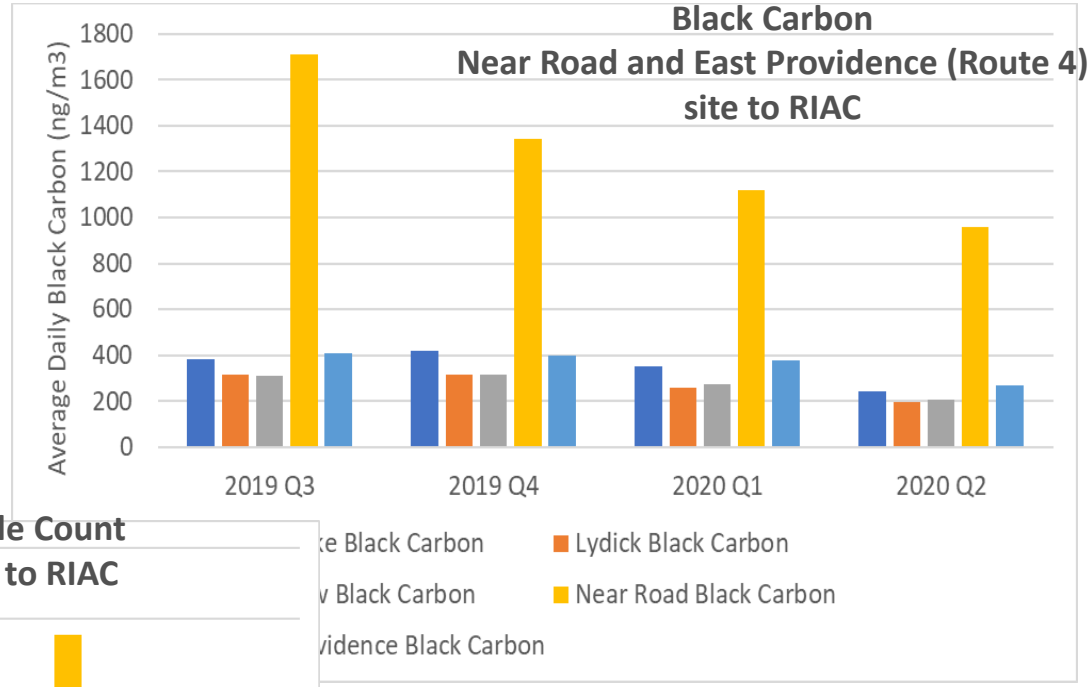
The March 2021 RIDOH annual report demonstrates data collected near I95 is 3-5 times higher, and much of black carbon detected comes from other sources

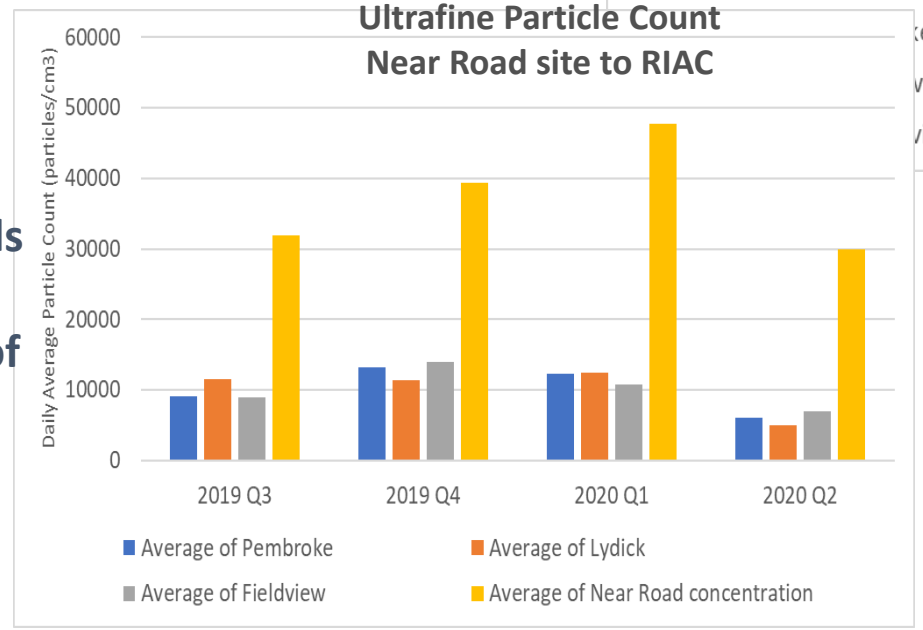
RIDOH annual report dated March 2021 concludes:

"…much of the BC detected comes from a source other than the airport"

"UFPs disperse rapidly through both distance and time while BC can have a much longer retention time, allowing detection of further sources."

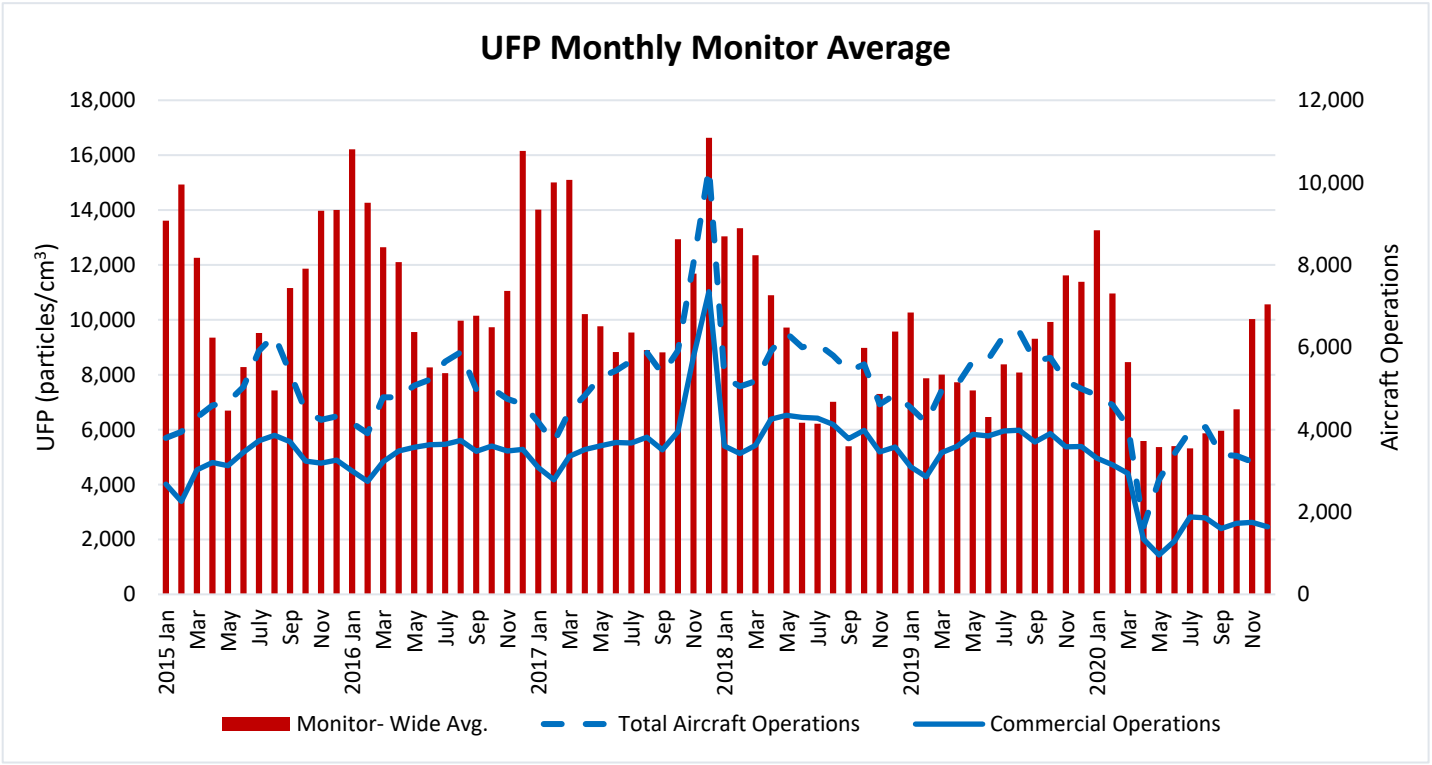
"For both contaminants, I-95 traffic levels were found to correlate with measured pollutant levels more than the number of daily flights"





RIDOH indicates that for quarter 2 of 2020, versus the previous three quarters, I-95 traffic was down 36.9% and Route 4 traffic down 25%.

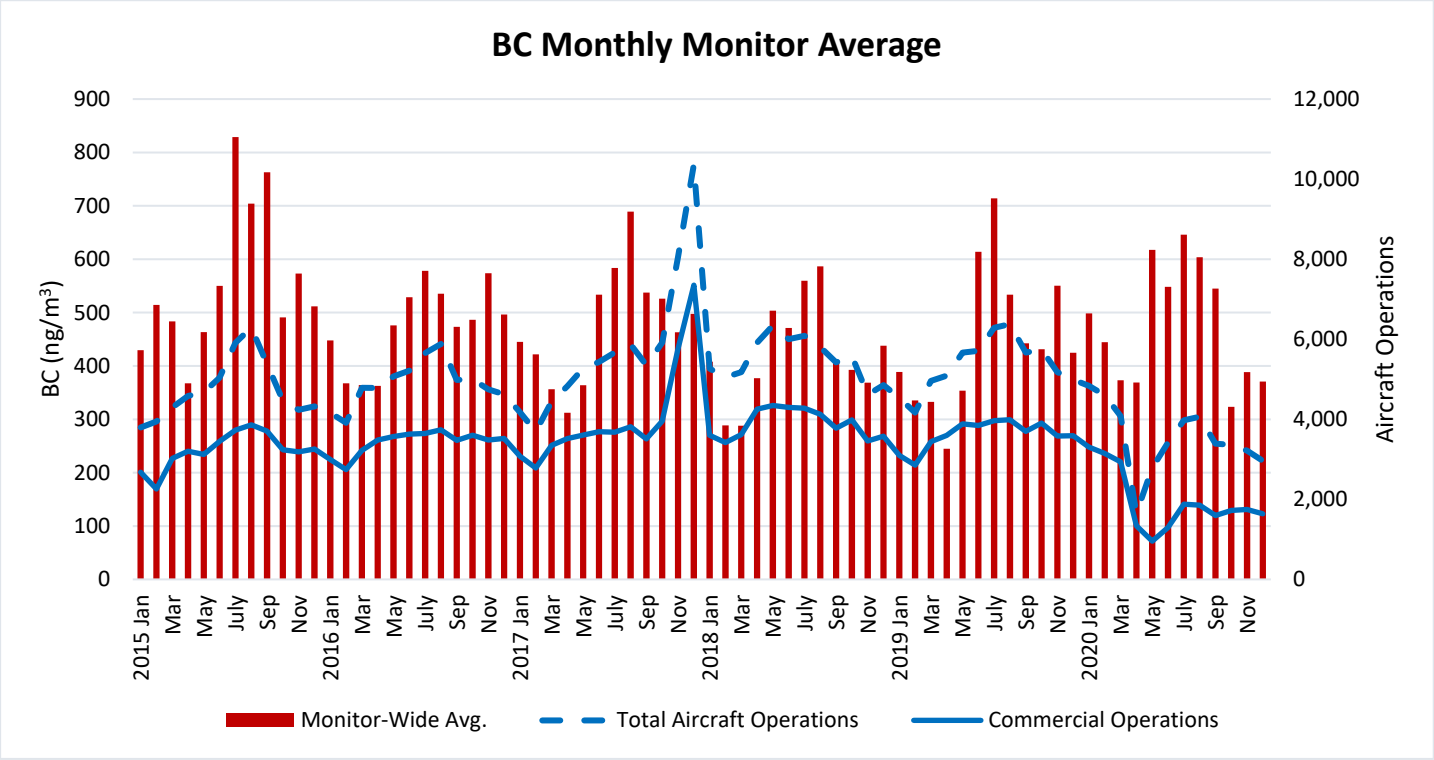
Statistical analysis: Aircraft operations in 2020 were likely not the cause of decreases in UFPs during the pandemic



Source: Air Quality Monitoring Data Analysis Technical Memorandum, prepared for the Rhode Island Airport Corporation, dated March 2021 by Crawford, Murphy & Tilly, Inc., in collaboration with Vanasse Hangen Brustlin, Inc.

- There is no clear relationship between monthly average UFPs and total or commercial aircraft operations
- There is no statistically significant correlation with total aircraft operations
- Statistical analysis reveals that decreases in UFP concentrations during 2020 are likely attributable to other sources of pollution.
  - Similar drop in UFPs in Q2 of 2018 and 2020 despite different levels of operations.
- There is a statistically significant positive relationship between commercial operations and monthly average UFPs.
  - This is due to elevated operations in November and December 2017.
  - Without these two months, the significance is eliminated.

Statistical analysis reveals relationship, but 76% of monitored BC changes are caused by factors and emission sources other than aircraft operations



- The average monthly correlation between BC and total aircraft operations is positive at 24%, indicating that 76% of monitored BC changes are caused by other factors and emission sources.
- A statistically significant correlation was not found between commercial operations and BC.
- In 2020, BC concentrations exhibit an increasing trend similar to prior years despite the decrease of aircraft operations which is also indicative of influence from other sources and factors.
- Aircraft operations are not likely the primary driver of changes of BC concentrations.

Source: Air Quality Monitoring Data Analysis Technical Memorandum, prepared for the Rhode Island Airport Corporation, dated March 2021 by Crawford, Murphy & Tilly, Inc., in collaboration with Vanasse Hangen Brustlin, Inc.

Conclusions

UFPs:

- The analysis revealed that there is no significant relationship between UFPs and total aircraft operations averaged over the four monitors.
- Decreases in UFP concentrations during the COVID-19 pandemic were most likely *not* caused by a decrease in total aircraft operations based on the statistical analysis.
- UFP changes are more likely related to decreases in other sources of pollution (e.g., motor vehicles, industrial activities, etc.).

BC:

- BC concentrations were statistically correlated to total aircraft operations throughout the time period analyzed.
- The correlation is significant, but low enough to indicate that additional sources are also driving BC concentrations.
- During the COVID-19 pandemic, BC concentrations follow a similar pattern as aircraft operations. However, the changes in the pandemic were not proportional, which indicates the influence of other sources.

Note: Monitors located on/near the airport are not likely representative of conditions in the community surrounding the airport.

Questions?

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