Modeling Airport-Related Air Pollutant Concentrations and Health Impacts
Project 18

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ASCENT
AVIATION SUSTAINABILITY CENTER

Motivations

- Multiple recent publications have concluded that aircraft arrival emissions can contribute significantly to ultrafine particulate matter (UFP) concentrations at appreciable distances from the airport, but it is unclear whether the findings are physically interpretable and robust

- Challenges for UFP:
  - High spatiotemporal variability
  - Complex pollutant dynamics
  - Multiple contributing sources/source sectors
  - Lack of ambient monitoring infrastructure
  - Limitations in emissions inventories (particle number vs. mass)
  - Limitations in dispersion models

Objectives

- Previous Study (Arrivals)
  - Measure UFP and BC concentrations at strategically selected sites near arrival flight paths
  - Quantify the contribution of flight arrivals to measured concentrations along a single arrival pathway

- Current Study (Arrivals and Departures)
  - Expanded field campaign to address unanswered questions related to aviation source attribution
    - Additional pollutants, additional sites, consideration of departures as well as arrivals
  - Develop insights about spatiotemporal patterns of the aviation-attributable portion of multiple air pollutants, determining implications for potential studies of health effects
  - Compare monitoring-based source attribution estimates with those derived from dispersion modeling

Outcomes and Practical Applications

- Outcomes
  - Refined statistical approaches for isolating contributions of flight arrivals and departures to ambient pollutant concentrations
  - Quantitative estimates of aviation source contributions relative to other sources

- Practical applications
  - Improved understanding of aviation impacts on air quality at varying distances from airport
  - Insights about both monitoring-based and modeling-based approaches for source attribution
  - Field protocols and observations that could provide foundation for health studies

Current – Study Approach

- **Monitoring Strategy:**
  - Field deployment from June 2020 – September of 2021
  - Four Stationary sites are simultaneously measuring PNC, BC, NO, NOx
    - Site selection based on being greater than 200 m from a major roadway near arrival and departure trajectories informed by prevalent wind direction and flight activity data
  - Mobile monitoring platform uses electronic vehicle (EV) to collect air pollution data between monitoring sites

- **Statistical Analysis Strategy**:
  - Descriptive statistics stratified across key covariates (i.e. month, 4R runway configurations and wind conditions)
  - Regression analyses of concentrations accounting for real-time flight locations (lat, long, altitude), meteorology, time of day, day of week

Current Approach - Monitoring Instruments

UFP Conc	BC	NO/NO$_2$	Met	Flight Activity

TSI CPC 3787 (1 sec)

MicroAeth AE51 (1-10 sec)
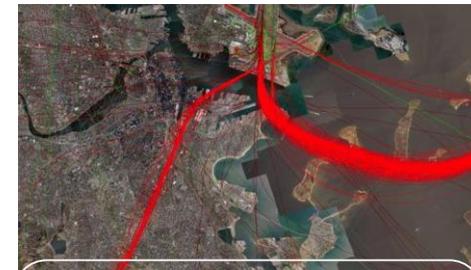
2BT NOx (1-10 sec)

Davis VantagePro (1-10 sec)

(3 -5 sec)

TSI FMPS 3091 (10 sec)

Current Approach – EV Mobile Monitoring

Led by Co-investigator John Durant, PhD Department of Civil and Environmental Engineering, Tufts University.

# Monitoring Sites for 2020 Field Campaign – Multiple LTO Flight Paths.

Stationary Site Selection

⭐ PNC Monitoring site

- Sites chosen to be > 200 m from major roadways
- Near population areas
- At varying distances from multiple runways based in part on historical wind direction and runway usage

Mobile Monitoring Route

- Route chosen to be > 200 m from major roadways
- Through population areas
- Want to capture a wide range of meteorological conditions.
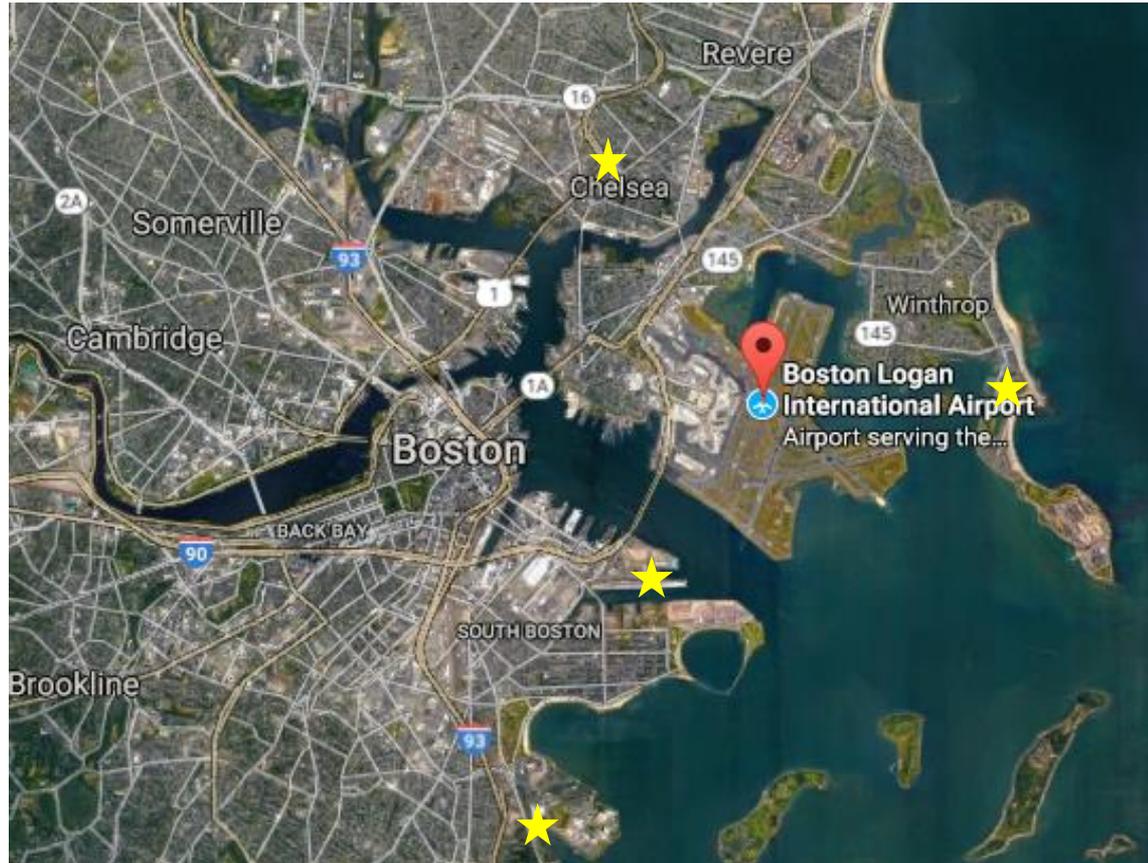
Schedule and Status

- Spring 2020: Research team development, instrument selection, site selection, mobile monitoring test runs

- Spring 2020: Update flight activity analytical dataset, review monitoring data and identify optimal sites for follow-up field campaign, purchase and prepare field equipment

- Spring – Summer 2020: update field protocols and obtain permission to sample at new sites

- June 2020 – August 2021: Field measurements

Summary

- Summary statement
  - Contributions of aircraft arrivals and departures to UFP concentrations are complex to characterize and vary greatly in time and space, and ultimately require fit-for-purpose monitoring and appropriate statistical analyses
  - Summary data and plots reinforce complexity and variability in UFP concentrations over time and space

- Next steps
  - Complete statistical analyses and new field campaign

- Key challenges/barriers
  - Developing physically interpretable insights about arrival contributions
  - Considering air pollution impacts within a broader exposure/health context

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- Tufts University: John Durant (Tufts)

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QUESTIONS?