Project 018 Measurements of Aviation Emission Contributions to Ambient Air Quality

Boston University School of Public Health

Project Lead Investigator

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University Participants

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- P.I.s: Kevin J. Lane, Assistant Professor; Jonathan I. Levy, Professor and Chair
- FAA Award Number: 13-C-AJFE-BU, Amendment 7
- Period of Performance: August 30, 2023, to September 30, 2025 ***(BU POP extended through September 30, 2026)***
- Tasks:
  1. Continued targeted mobile and stationary monitoring near the Boston Logan International Airport (BOS) to allow for future analyses of changing aviation source contributions to inform source attribution
  2. Conduct an ambient air pollution monitoring campaign near Dulles International Airport
  3. Provide data to ASCENT Project 019 to conduct calibration and validation of ambient air pollution dispersion models developed by ASCENT Project 019

Project Funding Level

The Federal Aviation Administration (FAA) provided $649,000 in funding. Matching funds were provided by a non-federal donor to the Women's Health Initiative cohort studies as cost-sharing support to Boston University through ASCENT Project 003.

Investigation Team

Boston University School of Public Health

Prof. Jonathan I. Levy, ScD (ASCENT BUSPH Director and ASCENT Project 018 Co-Investigator: Professor of Environmental Health, Chair of the Department of Environmental Health) is the Boston University P.I. for ASCENT. He initiated ASCENT Project 018 and serves as the director of BUSPH ASCENT research.

Prof. Kevin J. Lane, PhD (ASCENT Project 018 P.I.: Associate Professor of Environmental Health, Department of Environmental Health) joined the ASCENT Project 018 team in July 2017. Dr. Lane has expertise in the assessment of ultrafine particle (UFP) exposure, geographic information systems, statistical modeling of large datasets, and cardiovascular health outcomes associated with air pollution exposure. He has contributed to study design and data analysis strategies and, as of October 1, 2017, took over the primary responsibility for project execution. Dr. Lane also contributes to the manuscripts and reports produced.

Dr. Prasad Patil (Assistant Professor) is a machine-learning and regression modeling expert who is assisting Dr. Lane with modeling of the 2017–2019 UFP data.

Sean Mueller (doctoral student) has been analyzing aviation-related particulate number concentration (PNC) results obtained during COVID-19. Daniel Kojis is a doctoral student examining model generalizability and transferability between sites.

Breanna van Loenen and Maria Bermudez (research assistants) are supporting the analysis of mobile monitoring (MM) and stationary monitoring data.

Tufts University

Dr. John Durant, PhD (Associate Professor) oversees the Tufts Air Pollution Monitoring Laboratory (TAPL) team, leads the development of field study design, and contributes to scientific manuscript preparation.

Dr. Neelakshi Hudda, PhD (Research Professor) joined the ASCENT Project 018 team in September 2020 and is managing the TAPL team as well as mobility data analysis, field study design and implementation, and scientific manuscript preparation.

Camille Gimilaro, Olivia Moore, Isabelle Woollacott, and Lily Sandholm (undergraduate students) are working on the MM platform and helping to clean the air pollution data.

Project Overview

The primary goal of ASCENT Project 018 for 2024–2025 was to conduct an air pollution monitoring campaign beneath flight paths to and from BOS, using a protocol specifically designed to determine the magnitude and spatial distribution of UFPs in the vicinity of arrival flight paths. Data were collected to assess whether aircraft emissions, particularly arrival emissions, significantly contribute to UFP concentrations at appreciable distances from BOS. Task 1 aims to further investigate the contributions of variation sources to PNCs at stationary sites using regression and machine-learning models at BOS. Tasks 2 and 3 leverage the infrastructure previously developed for our field campaign and enable measurements that address a broader set of research questions than those evaluated in the previous monitoring year, with additional data collection for nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) to inform dispersion model validation work being conducted by ASCENT Project 019.

Our team continued our monitoring campaign to the summer of 2025 to collect and analyze near-airport air pollution measurements to determine the contributions of in-flight arrival and departure aircraft to ground-based concentrations. State-of-the-art air pollution monitoring technology that can measure different air pollutants every 1–5 s has been used. Stationary sites have been established at varying distances from flight paths for BOS, with measurements collected across multiple seasons. An MM system (electric vehicle) outfitted with the same monitoring equipment has also been employed to drive in airport neighborhoods to better characterize geographic variations in air pollution. Statistical analyses will compare the stationary and mobile measurements with flight activity data from the United States, FAA, and meteorology to determine aircraft contributions to ground measurements. Our team will compare these source attribution estimates with comparable outputs from atmospheric dispersion models.

A summary of all project methods and data collection is included below to describe the continued application of ASCENT Project 018 data and 2024–2025 study tasks.

Task 1 – Continue Targeted Mobile and Stationary Monitoring near the Boston International Airport to Allow for Analyses of Changing Aviation Source Contributions to Inform Source Attribution

Objectives

The mobile and fixed-site monitoring data collected under ASCENT Project 018 were analyzed to investigate the spatiotemporal patterns of aviation-related contributions to UFP, as well as the relative influence of flight arrivals and departures in different locations and underneath flights approaching different runways. Broadly, this effort builds on the methodological foundation developed under ASCENT Project 018 and within earlier PARTNER projects, in which our team developed and applied statistical techniques to model short-term pollution measurements with high variability and high autocorrelation. The fact that these data were collected during the pandemic across time periods in which flight activity changed substantially while traffic followed slightly different patterns provides a “natural experiment” that will enhance our ability to conduct source attribution.

Research Approach

Our team has used two statistical approaches to quantify aviation contributions to ambient air quality. First, multivariable generalized linear models were used to examine the association between air pollutant concentrations and real-time flight activity, accounting for aircraft locations in space relative to the monitor and including terms for wind speed/direction, temperature, mixing height, and other relevant meteorological covariates. Second, machine-learning regression models, such as random forest modeling and gradient boosts, were applied to improve model performance, while applying Shapley (SHAP) analysis to provide source attribution quantification. Each study site was modeled individually to assess the location-specific impact of aircraft arrivals and departures along with meteorological and other local environmental conditions, and in future work, combined models will be explored. Because of the complexity of interactions among predictors (i.e., flight activity will be influenced by wind speed and direction, which will also affect plume dispersion and resulting concentrations at individual monitors), our team explored advanced statistical techniques for covariate selection and model assembling, including random forest regression and other machine-learning regression techniques. Preliminary findings from the application of machine-learning techniques to our UFP measurements indicate that machine-learning methods are able to explain more variability than generalized linear models or related techniques. These predictions will subsequently be shared with ASCENT Project 019, where investigators are developing comparable estimates of aviation-attributable concentrations near BOS, and we will conduct analyses to compare predictions from dispersion models and regression models.

MM data were used to (a) generate summary statistics characterizing the spatial and spatiotemporal variability of measured pollutants in the study area, (b) aid in source attribution, and (c) build and evaluate spatially explicit predictive models of pollutant concentrations in East Boston, Chelsea, Revere, and Winthrop in Massachusetts. Exploratory spatial data analyses were performed to identify areas of clustering for spatial autocorrelation of PNC within the MM routes, which may warrant further analysis or special treatment in subsequent modeling efforts. Source apportionment of measured pollutants and drivers of variability in the MM data were examined via geographically weighted regression and/or cluster analysis.

With each of the regression models, the amount of measured air pollution attributable to flight is estimated on a short-term and long-term basis. In other words, by zeroing out the flight activity terms and determining the predicted concentrations, the portion of measured concentrations attributable to aircraft arrivals and departures can be ascertained.

Broadly, these analyses make multiple important contributions not available elsewhere. Our team worked with a unique dataset of stationary and mobile measurements collected over the first 2 years of the COVID-19 pandemic in a variety of locations near a major airport. Advanced statistical techniques were applied to better ascertain source contributions. This work builds upon the aviation air pollution exposure literature and yields novel insights.

Milestones

- Completed mobile and stationary monitoring and spatiotemporal data collection and preliminary analysis to elucidate the limitations of stationary monitoring alone in determining accurate UFP exposure across geographic locations around BOS.
- Published two manuscripts, with an additional three manuscripts being prepared for submission.
- Presented at the Aviation Emissions Characterization (AEC) meeting and ASCENT Fall and Spring 2025 meetings (Kevin Lane).

Major Accomplishments

During this year we have successfully published two manuscripts focused on aim 1. A summary of each paper is provided below.

Mueller, S., Patil, P., Levy, J., Hudda, N., Durant, J. L., Gause, E., van Loenen, B. D., Bermudez, M., Geddes, J. A., & Lane, K. J. (2025). Quantifying Aviation-Related Contributions to Ambient Ultrafine Particle Number Concentrations Using Interpretable Machine Learning. *Environmental Science & Technology, 59*(37), 19942-19952. doi: 10.1021/acs.est.5c07989.

Mueller et al. (2025) applies interpretable machine learning (XGBoost with SHAP analysis) to quantify aviation-related contributions to ultrafine PNCs near the airport using an 8-year dataset from BOS. By integrating runway-specific flight activity, on-ground operations, road traffic, and meteorology, the model achieved strong predictive performance ($R^2 = 0.66$; coefficient of determination) and revealed that aircraft arrivals exert the greatest influence on PNC, particularly under crosswind conditions that enable lateral plume dispersion. Meteorological factors such as wind direction, planetary boundary layer height, and temperature strongly modulate aviation impacts, with shallow mixing layers and cold conditions amplifying concentrations. These findings highlight the complex, nonlinear interactions between aircraft emissions and atmospheric dynamics, providing a high-resolution framework for exposure assessment and informing strategies to mitigate UFP pollution near airports.

Figure 1 illustrates the spatial context of the study site and its relationship to BOS. Panel (a) shows the airport's runway configuration and the monitoring site located approximately 4 km northwest of the airport, positioned to capture aviation-related UFP emissions under southeasterly winds. Panel (b) presents a wind rose summarizing hourly wind data from 2014–2022, highlighting that impact-sector winds (135°–175°) occur about 7% of the time, placing the site downwind of the airport. This figure establishes the physical basis for interpreting observed UFP patterns and underscores the importance of wind direction in determining aviation influence on local air quality.

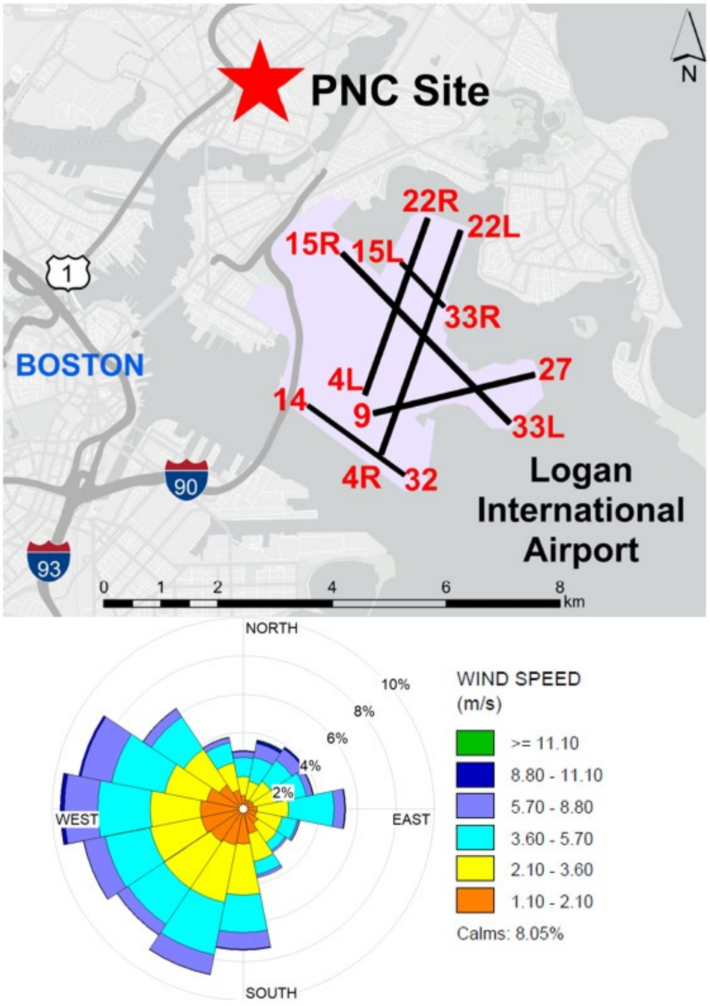

Figure 1. (a) Runway configuration at Logan International Airport and location of the monitoring site. (b) Wind rose 2014-2022 hourly data from the HRRR model.

Figure 2 consists of two panels summarizing feature importance and directional dependencies derived from SHAP analysis. Panel (a) ranks the top 15 predictors of PNC by mean absolute SHAP value (MASV), showing that meteorological variables—particularly surface wind direction, temperature, and wind speed—dominate model influence, followed by road traffic and specific runway operations (notably arrivals on 22L and departures on 22R). Panel (b) displays pollution roses of SHAP values for these aviation and traffic features, revealing that aircraft contributions peak under high-speed southeasterly winds, while road traffic shows minimal wind dependence. Together, these plots demonstrate the nonlinear and episodic nature of aviation impacts compared to more stable roadway contributions.

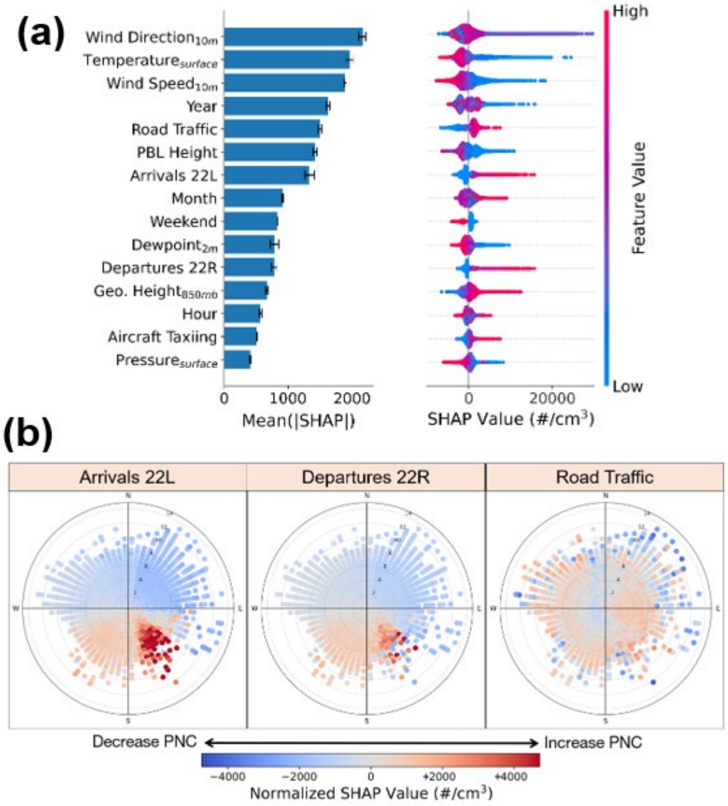

Figure 2. (a) Top 15 features ranked by mean absolute SHAP values (MASV), representing their contributions to predicted PNC (particles/cm³). Left: MASV with error bars (±1 standard deviation) across model runs (n = 10). Right: distribution of SHAP values colored by feature value. (b) Pollution roses showing binned hourly average SHAP values (normalized to 99th percentile) for aircraft arrivals on runway 22L, aircraft departures on runway 22R, and automobile road traffic, plotted against wind direction and speed.

Figure 3 presents bivariate partial dependence plots illustrating the joint marginal effects of wind direction and runway operations on predicted PNC. Results for runways 22L and 22R show minimal marginal effects under their typical southwest wind alignment but substantial increases during southeast crosswinds, with departures exerting stronger per-operation impacts than arrivals. Runway 15R, aligned with the impact sector, shows elevated contributions from arrivals during high activity periods, while departures have negligible influence—likely due to rapid climb-out and plume dispersion. This figure highlights how operational patterns and wind conditions interact to shape aviation-related PNC variability.

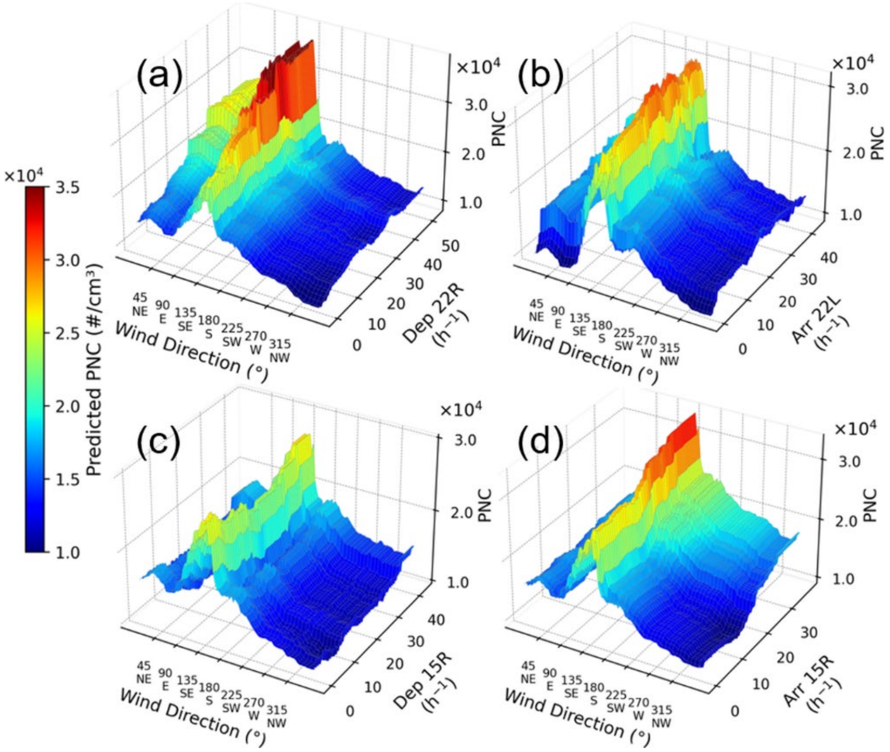

Figure 3. Bivariate partial dependence plots for predicted particle number concentration (particles/cm^3) showing the joint marginal contribution of surface wind direction and operations on runways (a) 22R (b) 22L (c-d) 15R.

Overall, this work shows our team successfully developed a machine-learning model to predict PNCs based on changing meteorology and flight activity variables. PNC data were collected by TSI® water-based condensation particle counters (CPC) at 1-s resolution and then aggregated to 15-min and hourly averages. The model was developed based on 2017 data collected from six stationary air monitoring sites along the 4R/4L runways, which is the most frequently used arrival pathway into BOS. PNC data were collected by CPC devices at 1-s resolution and then merged into hourly averages as a proxy for the total UFP.

van Loenen, B. D., Black-Ingersoll, F., Durant, J. L., Levy, J. I., Patil, P., Mueller, S., Gause, E., Hudda, N., Bermudez, M., & Lane, K. J. (2025). Aircraft Arrival and Departure Contributions to Ultrafine Particle Size Distribution in a Near-Airport Community. *Environmental Science & Technology, 59*(25), 12853-12864. doi:10.1021/acs.est.5c04799.

Van Loenen et al. (2025) examines particle size distribution and source attribution. Aviation activities influenced UFP concentrations and size distributions at monitoring sites near BOS. Using 21 months of continuous monitoring near BOS, the study measured particle size distributions across 32 channels and linked them to flight activity and meteorological conditions. Results show that, overall, PNC were significantly higher when the site was downwind of the airport, with nucleation-mode particles (particularly 8–12 nm) dominating during these conditions. Arrivals contributed disproportionately to UFP exposure, producing smaller modal diameters (9–11 nm) and higher PNC compared to departures, which were associated with larger Aitken-mode particles (39–52 nm).

Our principal component analysis confirmed that nucleation-mode particles strongly correlate with arrival activity, especially under downwind conditions. The findings highlight that exposure to aviation-related UFP is primarily driven by landing aircraft rather than departures, and that particle size distribution can serve as a robust indicator for source attribution. This work underscores the importance of incorporating size-resolved measurements in air quality assessments

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and suggests that mitigation strategies should consider the unique characteristics of aviation emissions to protect public health.

Figure 4 provides a comparison of the PNC size distribution aggregated to hourly level. Figure 4 panel (a) provides map of the monitoring site in Winthrop, MA, showing its spatial relationship with BOS runways and nearby highways. The site is located approximately 1 km from the runway endpoints, directly beneath common landing and departure paths for runways 9 and 27. This figure emphasizes the strategic positioning of the monitoring location to capture aviation-related UFP emissions while minimizing interference from roadway traffic, as the nearest major highway is over 4 km away. The map also illustrates the surrounding geography, including Boston Harbor and Deer Island, which helps contextualize potential secondary sources and prevailing wind directions. Figure 4(B) displays polar plots of hourly averaged UFP concentrations for particles smaller than 30 nm, stratified by wind speed and direction. The plots reveal that nucleation-mode particles (particularly those between 9–11 nm) exhibit sharp concentration spikes during westerly winds, which place the monitoring site downwind of the airport. This pattern strongly supports aviation as the dominant source of these particles under impact-sector conditions. Larger particles do not show similar directional dependence, reinforcing the unique size signature of aircraft emissions. The figure visually demonstrates how meteorology interacts with source activity to influence near-airport particle size distribution.

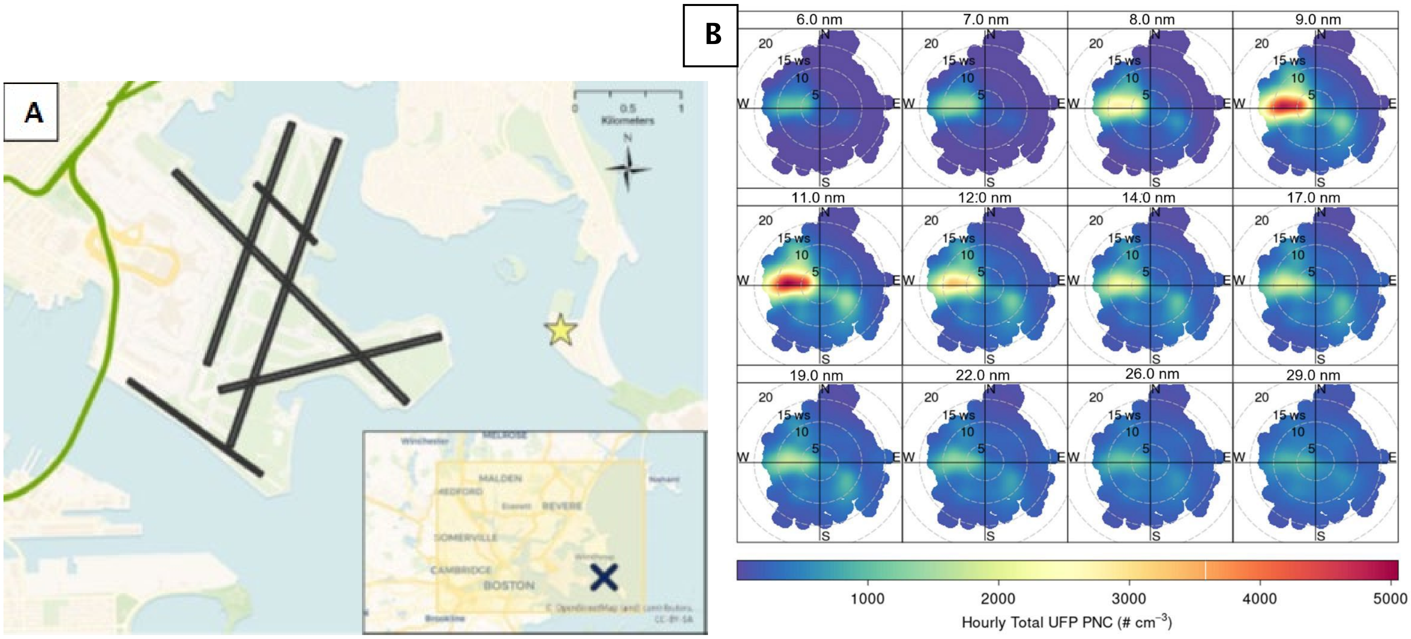

Figure 4. Panel (a) Location of monitoring site in Winthrop, MA; Panel (b) pollution polar plots of hourly average UFP contributions.

Figure 5 compares particle size distributions during two operational scenarios: hours dominated by arrivals on runway 27 versus departures on runway 9. Arrivals produce a narrow peak centered at 9–11 nm, with particles in the 7–17 nm range accounting for more than half of total PNC. In contrast, departures yield a broader distribution dominated by Aitken-mode particles (29–108 nm), peaking around 39–52 nm. Total PNC during arrivals is nearly four times higher than during departures, and peak modal concentrations differ by a factor of nine. This figure underscores the distinct size profiles associated with landing versus takeoff operations and highlights arrivals as the primary contributor to nucleation-mode particles in the study area.

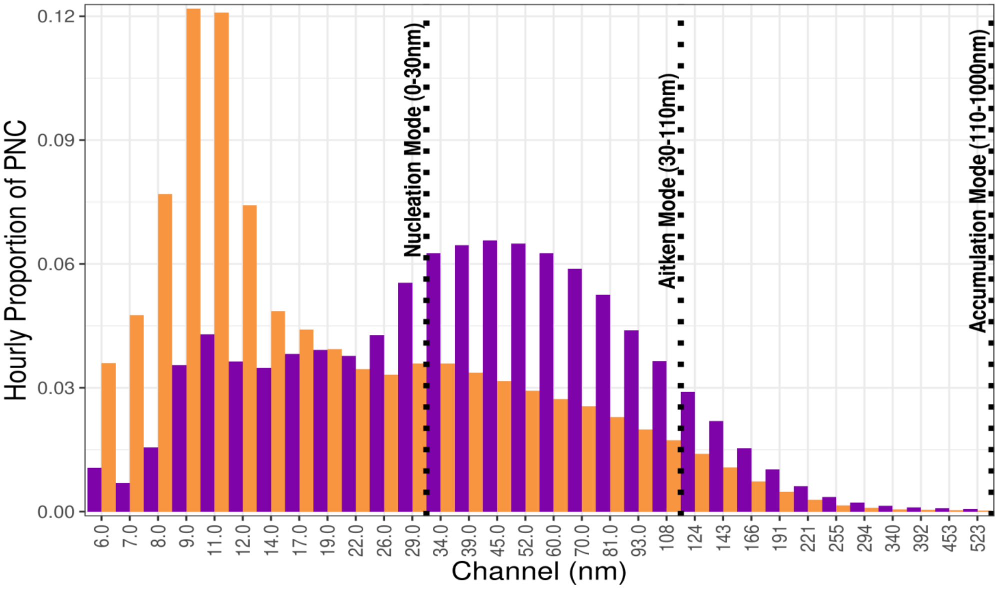

Figure 5. Proportion of total hourly PNC attributed to specific particle sizes during the arrivals scenario (orange, five or more arrivals on runway 27) and the departures scenario (purple, five or more departures on runway 9).

The principal component analysis model (PCA) identified three clusters, with Cluster A—composed of the smallest particle sizes (<30 nm)—closely associated with aviation activity indicators such as arrivals on runway 27 and departures on 33L. Within this cluster, particles between 8–12 nm exhibit the strongest cohesion, confirming their role as markers of aircraft emissions. Larger particles (39–294 nm) form an opposing cluster, indicating an inverse relationship with aviation activity. This visualization provides statistical evidence that nucleation-mode particles are most representative of aviation sources, particularly under downwind conditions. Figure 6 consists of two panels: (a) contributions of particle size bins to PCA variance and (b) overall particle size distribution across the 21-month study period. Panel (a) shows that nucleation-mode particles (<30 nm), especially those around 10–12 nm, dominate variance explained by the first two principal components, aligning with aviation-specific clusters identified earlier. Aitken-mode particles contribute modestly, while accumulation-mode particles (>200 nm) have negligible influence. Panel (b) confirms a persistent size distribution peak at 9–11 nm throughout the monitoring period, reinforcing the strong and consistent impact of aircraft emissions on UFP exposure.

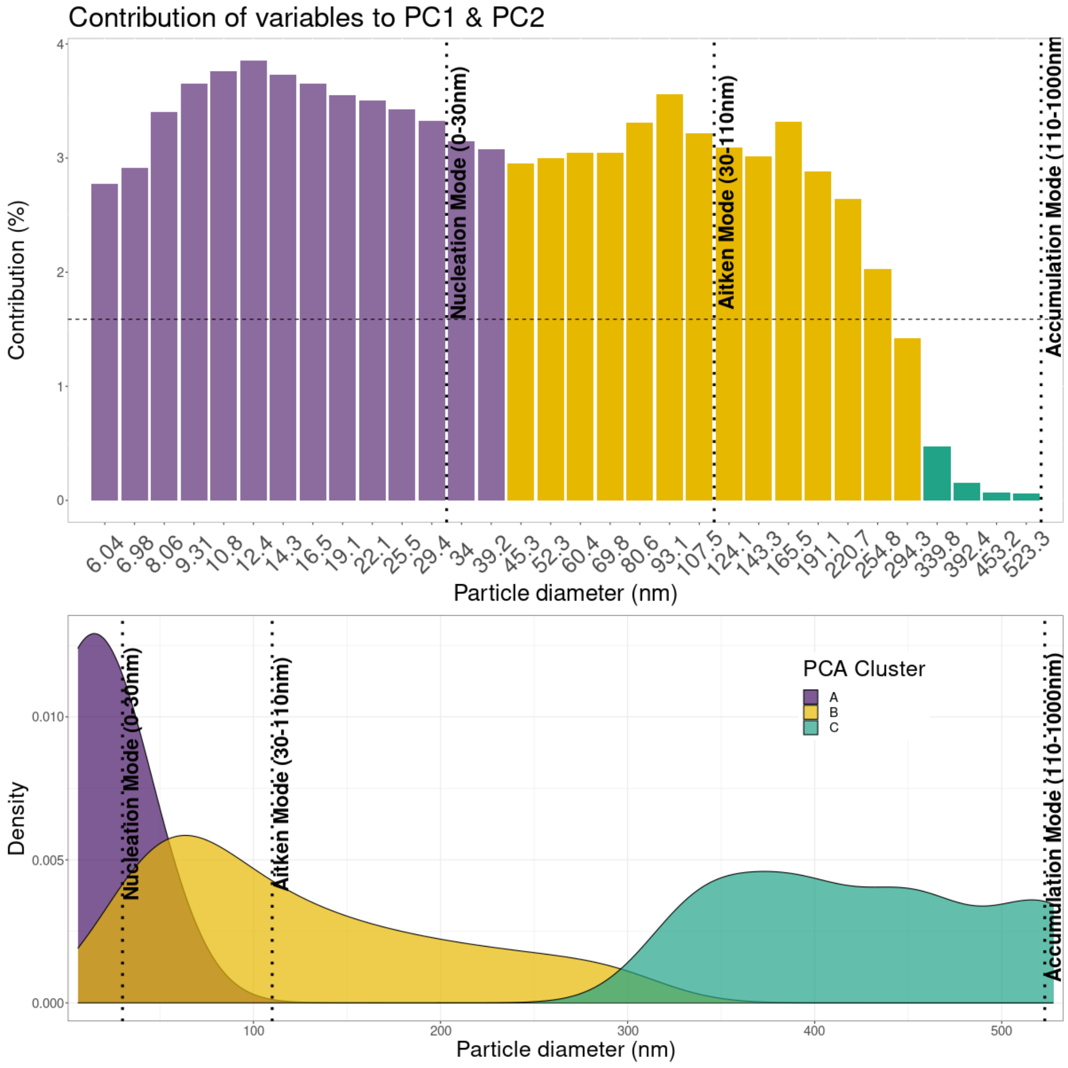

Figure 6. Two charts showing contributions of PC1 and PC2 to variance explained in Model 2 among particle size variables only.

Our team plans to continue to collect PNC data near BOS and we are in the process of expanding models to all study areas by combining the MM data with stationary models.

Publications

Chung, C. S., Lane, K. J., Black-Ingersoll, F., Kolaczyk, E., Schollaert, C., Li, S., Simon, M. C., & Levy, J. I. (2023). Assessing the impact of aircraft arrival on ambient ultrafine particle number concentrations in near-airport communities in Boston, Massachusetts. *Environmental Research, 225* (15 May 2023). https://doi.org/10.1016/j.envres.2023.115584

Mueller, S. C., Hudda, N., Levy, J. I., Durant, J. L., Patil, P., Lee, N. F., Weiss, I., Tatro, T., Duhl, T., Lane, K. (2022). Changes in ultrafine particle concentrations near a major airport following reduced transportation activity during the COVID-19 pandemic. *Environmental Science & Technology Letters, 9*(9), 706-711. https://doi.org/10.1021/acs.estlett.2c00322

Mueller, S., Patil, P., Levy, J., Hudda, N., Durant, J. L., Gause, E., van Loenen, B. D., Bermudez, M., Geddes, J. A., & Lane, K. J. (2025). Quantifying Aviation-Related Contributions to Ambient Ultrafine Particle Number Concentrations Using

Interpretable Machine Learning. *Environmental Science & Technology, 59*(37): 19942-19952. doi: 10.1021/acs.est.5c07989. https://pubs.acs.org/doi/10.1021/acs.est.5c07989

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Outreach Efforts

- Lane, K. J., "Health Effects of Fine Particulate Matter, Ultrafine Particle Exposure and Co-Benefits of SAF." Presented at Commercial Aviation Alternative Fuels Initiative (CAAFI) Webinar Series: Air Quality & Non-CO2 Benefits of Sustainable Aviation Fuel (SAF.) June 4, 2025.
- Lane, K. J., "Measurements of Aviation-Related Air Quality Lessons Learned from Ultrafine Particle Studies In Massachusetts." Presented to the Massachusetts Environmental Policy Act (MEPA) Review Committee. June 16, 2025.
- Durant, J. L. "Mobile monitoring findings from ASCENT Project 018 research." Presented to the MEPA Review Committee. July 21, 2025.
- Presented ASCENT Project 018 air pollution monitoring and modeling at the ASCENT Fall 2024 meeting.

Presentation

Mueller, S., Patil, P., Levy, J. I., Hudda, N., Durant, J. L., Gause, E., Loenen, B. V., & Lane, K. J. (2024, October 20-24). *Examining Impacts of Cross-Validation Approaches on Machine Learning Model Performance for Ultrafine Particle Exposure Assessment* [Oral presentation]. International Society for Exposure Science 2024 Annual Meeting, Montreal, Canada.

Awards

None.

Student Involvement

Sean Mueller, PhD student in the Department of Environmental Health, Boston University
Daniel Kojis, PhD student in the Department of Biostatistics, Boston University

Plans for Next Period

- Publish our remaining three manuscripts.
- Develop a combined stationary and MM machine-learning model using data from 2020–2024.

Task 2 - Conduct an Ambient Air Pollution Monitoring Campaign Near Dulles International Airport

Boston University School of Public Health

Objectives

To expand the generalizability of our work conducted at BOS, our team conducted mobile and stationary monitoring in 2024-2025 at Dulles International Airport (IAD). This offered various levels of complexity of urban sources, operations and meteorology in addition to our Boston data to support future modeling efforts for both ASCENT Projects 018 and 019. To date, the majority of UFP aviation monitoring and modeling has been conducted at only a few United States airports (i.e., BOS, Seattle-Tacoma International Airport [SEA], and Los Angeles International Airport [LAX]). While our team and other researchers have used these measurements to quantify source contributions, the generalizability and transferability of our findings to other airports need to be systematically analyzed. This is planned for the next statement of work (SOW) for ASCENT Project 018 to analyze the data collected in 2024-2025. Specifically, key factors need to be assessed that can impact the ground-level concentrations and thus the relative contribution of airport-related sources. This includes the complexity of urban sources surrounding the airport, airport operations, meteorology, and terrain. By studying these factors systematically, adjustments are made in modeling and the resulting estimates. An additional limitation of previous studies is that they have often either been very time-intensive or unable to fully characterize source contributions. Our team, therefore, also wants to help determine a more efficient approach for monitoring and characterizing the air quality impacts at other airports.

Research Approach

Our team initiated stationary monitoring and MM at the new site (IAD). Our team aims to investigate the following questions: (1) Can we distinguish an airport's impact on air quality near the airport? If so, what is the impact? 2) How do we develop a generalized understanding of the impact around airports? To initiate the IAD monitoring campaign, the team has collected and analyzed stationary and mobile data in different wind conditions. Preliminary stationary monitoring data were collected at multiple locations near the airport in 2023, with longer-term monitoring at three locations from 2023 to 2024 identified in Figure 6. The initial simultaneous stationary data collected from November 1, 2023, to Summer 2024 was used to create pollution roses that inform the scale and magnitude of impact (Figure 8).

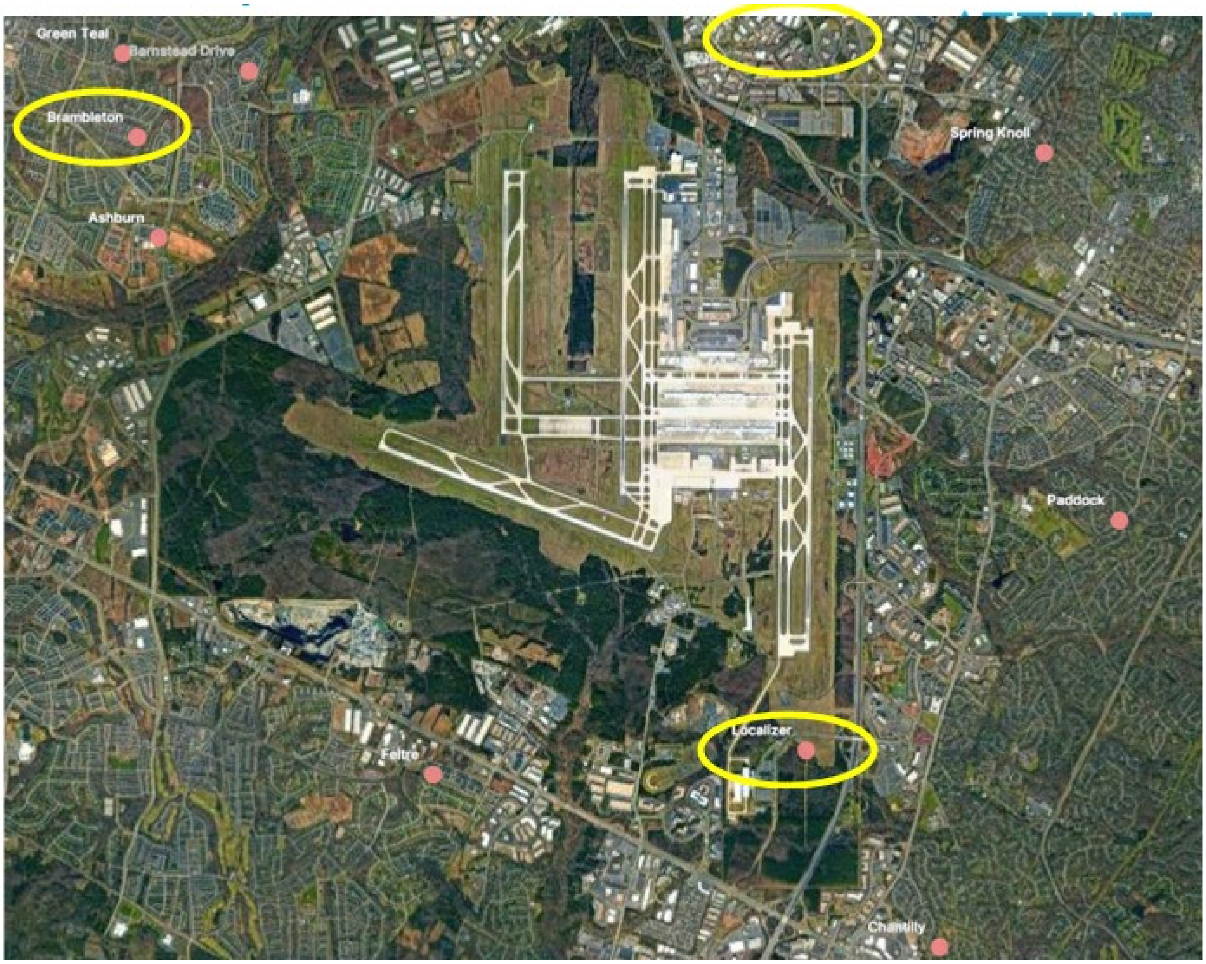

Figure 7. Stationary monitoring locations and data collection for 2024-2025.

Milestones

- Presented our findings at the AEC Roadmap/ASCENT meeting in May 2024 with a showing of the electric vehicle (EV) and instrumentation and monitoring equipment.
- Presented results at the Fall 2024 ASCENT meeting.

Major Accomplishments

Our team has collected over 15 million 1-second measurements of PNC covering three seasons of stationary monitoring near IAD. In Figure 8, each dot represents the hourly average UFP number concentration as a function of wind direction and wind speed. The bearing of each point represents the (hourly average) direction from which the wind is deriving. The distance of each point from the center is proportional to the hourly average wind speed from 0 mph (near the center) to 10 mph (near the outside). The windrose at left indicates the main directions from which the wind derives at IAD. Northwest winds are common in winter; southwest winds are common in summer. The UFP rose for Localizer shows that (for winter months) the highest concentrations occur during northwest winds. The UFP rose for Brambleton shows that (for winter months) the highest concentrations occur during southeast winds. These impacts clearly point to the airport as being a major source of PNC at these two sites. Notice that the black dots are as high as 100,000 particle/cm^3.

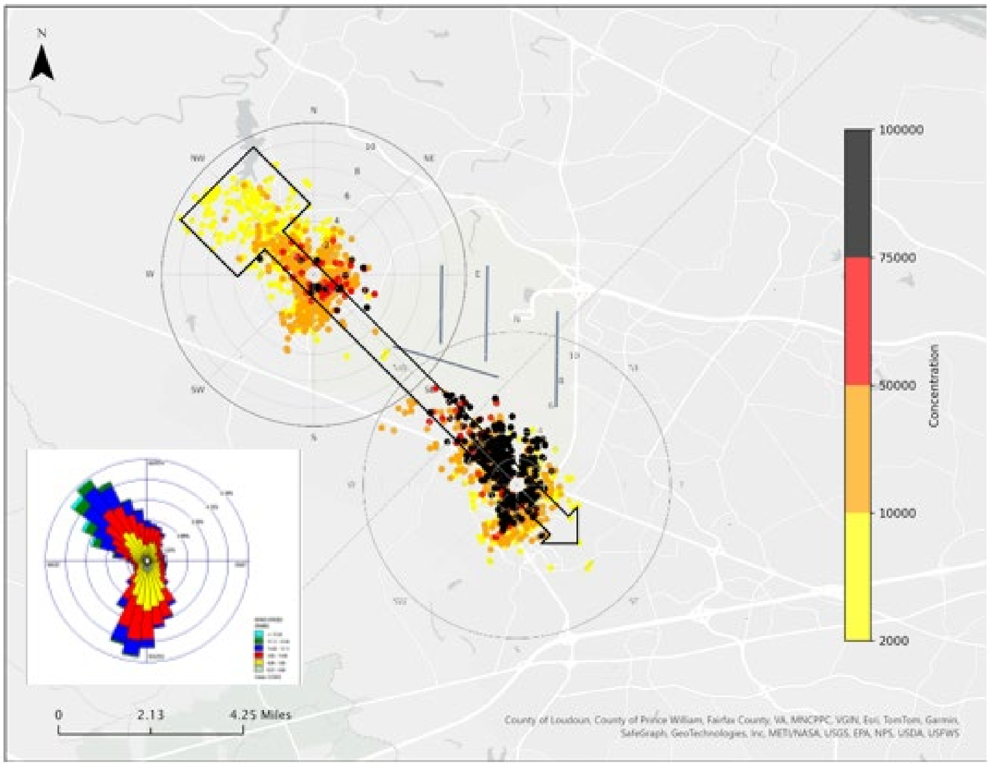

Figure 8. Pollution rose plot for the data at two long-term monitoring sites from fall 2023 through winter 2024 at Dulles International Airport.

Using MM data, we compared exposures to PNC and NO_2 to identify meteorological and aviation conditions that produce simultaneous peaks in both pollutants. Figure 9 illustrates MM results for PNC and NO_2 on a day with steady south-southeast winds, when the monitoring route was downwind of the airport and aircraft were flying over the airport neighborhood. Measurements were collected at 1-second intervals along a 15–20 m route. Spatial patterns for PNC and NO_2 revealed a clear downwind dispersion with a distance-decay gradient, particularly pronounced for UFP. While both pollutants exhibited some similar spatial trends, distinct differences were observed, including far-field NO_2 contributions linked to departures versus landings.

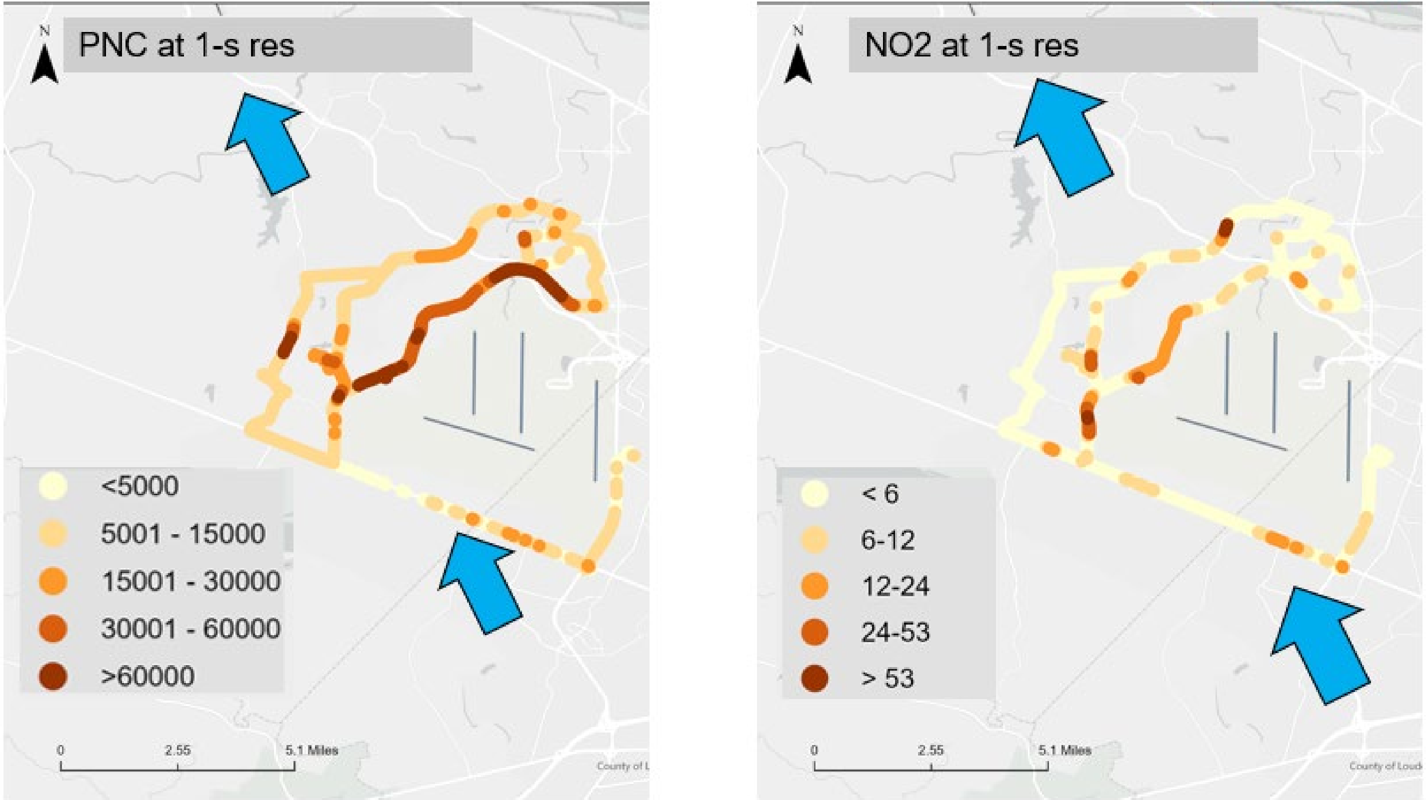

Figure 9. Comparison of particle number concentration (PNC) and nitrogen dioxide (NO_2) mobile monitoring (MM) data.

This MM map in Figure 10 displays the 5th percentile concentrations rolling averages of 30-s data. The wind was blowing from the northeast to the southwest at a speed of 5.6 mph.

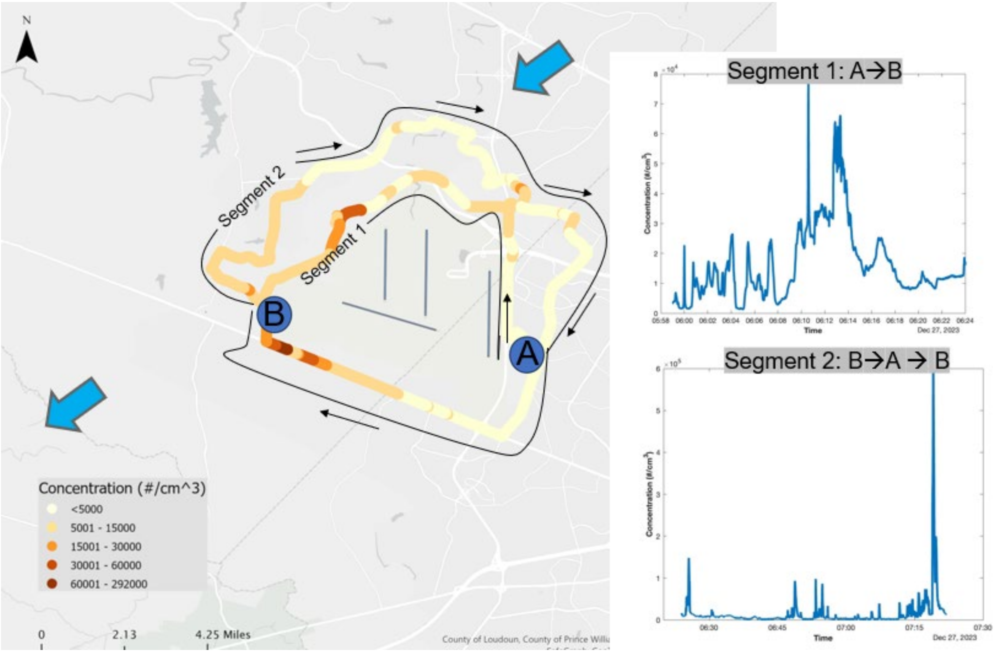

Figure 10. An example of mobile monitoring (MM) results for particle number concentration (PNC) and nitrogen dioxide (NO_2) concentrations for a single day with steady south-southeast winds downwind of BOS.

Publications

A manuscript is being developed on the descriptive analyses of the UFP data near IAD.

Outreach Efforts

- Presented our findings at the Spring AEC/ASCENT meeting in May 2024 with a showing of the EV and instrumentation and monitoring equipment.
- Presented results at the Fall 2025 ASCENT meeting.

Awards

None.

Student Involvement

Camille Gimilaro, doctoral student in Civil and Environmental Engineering, Tufts University.

Plans for Next Period

- Continue collecting air pollution data by moving NO_2 and SO_2 equipment to the stationary monitoring sites in Spring 2026.
- Conduct analysis on the transferability of UFP and NO_2 models developed under ASCENT Projects 018 and 019 to IAD in future years of the project. This will inform source attribution statistical models and the AERMOD Modeling System.[1]

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[1] AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts.

Task 3 – Provide Data to ASCENT Project 019 to Conduct Calibration and Validation of Ambient Air Pollution Dispersion Models Developed by ASCENT Project 019

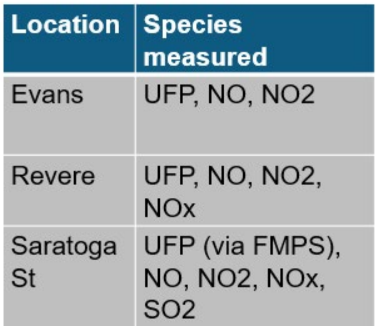
Boston University School of Public Health

Objectives

Our team is collecting data on NO/NO_2/NO_x at three different sites in Revere, East Boston and South Boston, MA, and data on SO_2 in East Boston, MA, to inform calibration and validation of dispersion models created by ASCENT Project 019. Development of descriptive analyses of these datasets continued to inform the ASCENT Project 019 data analysis efforts. Our estimates of aviation-attributable NO/NO_2/NO_x concentrations will be directly shared with ASCENT Project 019 for comparison with dispersion model estimates in future study periods. While our team has constructed numerous regression models for source attribution within ASCENT Project 018, the richness of these datasets (including multiple pollutants, both fixed-site and mobile measurements over a lengthy period, and the potential for synthesizing multiple fixed-site and mobile measurements for the same period) will allow for key refinements that will improve estimation and directly inform dispersion model validation.

Research Approach

Our team has continued working directly with ASCENT Project 019, with the long-term objective of improving dispersion modeling and quantifying arrival and takeoff aircraft contributions to NO_2 and SO_2 concentrations near BOS. In collaboration with ASCENT Project 019, data are shared to provide monitored data and to coordinate the collection of flight activity data to be used in both projects. Team members from ASCENT Project 018 and ASCENT Project 019 are coordinating support of each other's continued progress. ASCENT Project 018 staff have prepared analysis-ready datasets that combine all of our stationary air pollution monitoring data from the 2024 and 2025 monitoring campaign merged with relevant and timely meteorology data as well as runway-specific flight activity data at BOS and have shared these datasets with ASCENT Project 019 for use in their dispersion models.



Location	Species measured
Evans	UFP, NO, NO2
Revere	UFP, NO, NO2, NOx
Saratoga St	UFP (via FMPS), NO, NO2, NOx, SO2

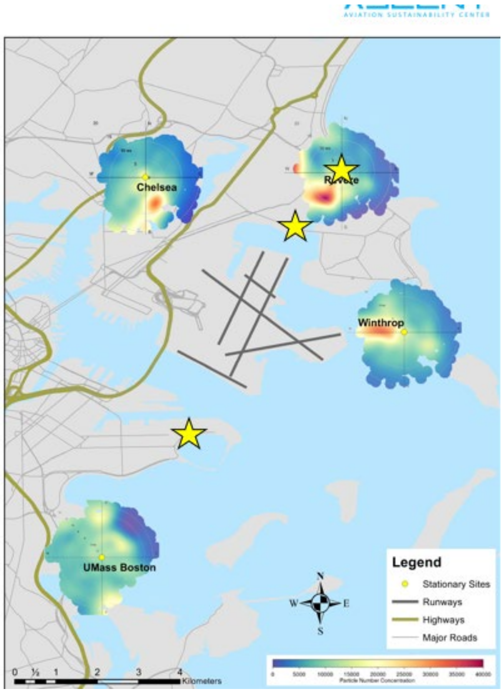
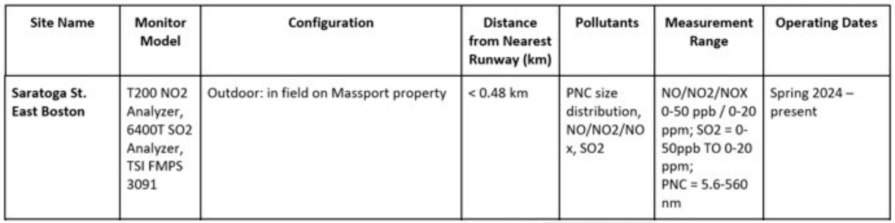
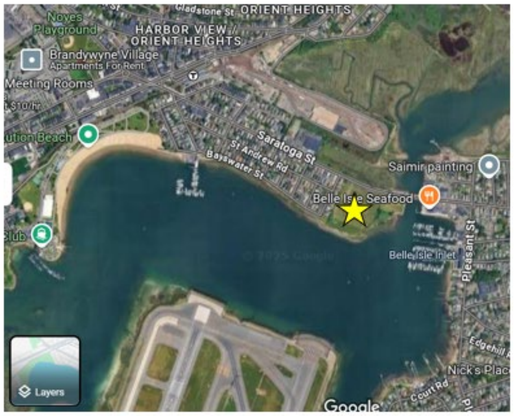


Figure 11. Pollution distribution by wind direction and wind speed for each monitoring site from previous analyses along with starred locations for monitoring sites for 2024-2025 campaign.

Figure 12 illustrates the monitoring site zoomed in along with the equipment location.



Site Name	Monitor Model	Configuration	Distance from Nearest Runway (km)	Pollutants	Measurement Range	Operating Dates
Saratoga St. East Boston	T200 NO2 Analyzer, 6400T SO2 Analyzer, TSI FMPS 3091	Outdoor: in field on Massport property	< 0.48 km	PNC size distribution, NO/NO2/NOx, SO2	NO/NO2/NOX 0-50 ppb / 0-20 ppm; SO2 = 0-50ppb TO 0-20 ppm; PNC = 5.6-560 nm	Spring 2024 – present



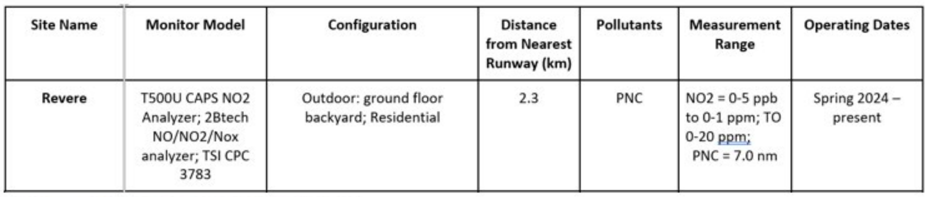
T200 - NO, NO2, NOx

Range: 0-50 ppb / 0-20 ppm

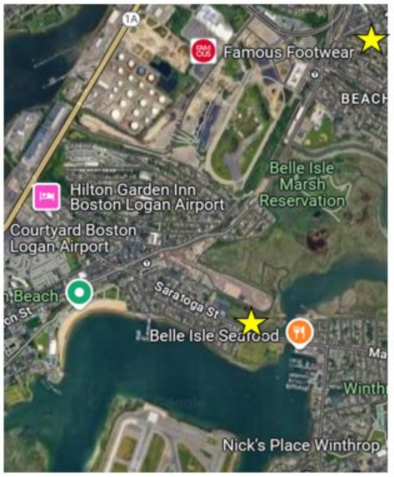
6400T / 6400TH

Sulfur Dioxide Analyzer

Fast Mobility Particle Sizer (FMPS) 3091



Site Name	Monitor Model	Configuration	Distance from Nearest Runway (km)	Pollutants	Measurement Range	Operating Dates
Revere	T500U CAPS NO2 Analyzer; 2Btech NO/NO2/Nox analyzer; TSI CPC 3783	Outdoor: ground floor backyard; Residential	2.3	PNC	NO2 = 0-5 ppb to 0-1 ppm; TO 0-20 ppm; PNC = 7.0 nm	Spring 2024 – present



CAPS NO2 Analyzer

2B Tech405 nm NO/NO2/NOx Analyzer

TSI CPC 3783

Site Name	Monitor Model	Configuration	Distance from Nearest Runway (km)	Pollutants	Measurement Range	Operating Dates
Evans Field South Boston	T500U CAPS NO2 Analyzer, TSI FMPS 3091	Outdoor: in park; residential	1.6 km	PNC size distribution, NO2, SO2	NO2 = 0-5 ppb to 0-1 ppm; TO 0-20 ppm; PNC = 5.6-560 nm	Summer 2024 - present

Figure 12. Monitoring site locations, equipment and setup.

This sharing of resources across projects allows both teams to avoid duplicating efforts, thus accelerating research progress. Sharing data also ensures that the results of our individual modeling approaches will be comparable, thus providing helpful context in interpreting the varied approaches. To facilitate data sharing between project groups, ASCENT Project 018 has granted access to their internal data storage and analysis server cluster environment to members of ASCENT Project 019.

Milestones

- Prepared similar analysis-ready data for the current and ongoing stationery and MM campaigns around BOS that are ready to be shared when needed.
- Created a data-processing pipeline to periodically clean and prepare collected datasets during the current monitoring campaign.
- Used ASCENT Project 018 data to prepare multiple publications by the ASCENT Project 019 team.

Major Accomplishments

- Shared all analysis-ready data from the 2024-2025 monitoring period with the ASCENT Project 019 team.
- Held meetings to exchange knowledge and collaborate on model interpretation.

Publications

None.

Outreach Efforts

None.

Awards

None.

Student Involvement

None.

Plans for Next Period

- Continue to provide ASCENT Project 019 with additional raw air pollution data as well as modeled PNC and NO_2 and SO_2 contributions.