Aviation Contributions to Ultrafine Particle Concentrations in Communities Surrounding Boston Logan International Airport*

Durant JL[1], Duhl TR[1], Hudda N[1], Moore O[1], Tatro TS[1], Mueller S[2], Van Loenen B[2], Gause E[2], Black-Ingersoll F[2], Levy JI[2], Lane KJ[2]

[1]Department of Civil and Environmental Engineering, Tufts University, 200 College Avenue, Medford, MA 02155, USA; [2]Department of Environmental Health, Boston University School of Public Health, 715 Albany Street, Boston, MA, 02118, USA

Background. Exposure to combustion-generated ultrafine particles (UFP) is associated with adverse health effects including asthma, heart disease, and cancer. Major roadways have been investigated as UFP source areas; however, to date relatively little work has been done to characterize UFP near large and more complex sources such as airports.

Objective. Our objective was to use a combination of monitoring approaches to characterize UFP near Boston Logan International Airport (Boston, MA, USA) with the broader goal of developing scalable and generalizable methods that may be useful at other airports.

Methods. The impacts of Boston Logan (BOS) on air quality are difficult to quantify because the airport operates with three different runway orientations that are preferentially used depending on prevailing winds, leading to intermittent impacts in near-airport communities. To address this, we have employed different monitoring techniques including stationary monitoring, fixed-route mobile monitoring, high-spatial-resolution adaptive mobile monitoring, and droning to better understand spatial and temporal variations of UFP near the airport.

Results. Using stationary monitoring we observed that at sites 4.0 and 7.3 km from the airport median ultrafine particle number concentrations (PNC) were 2- and 1.33-fold higher, respectively, when winds were from the direction of the airport compared to other directions. Similarly, based on mobile monitoring along a fixed route, which was monitored repeatedly on different days of the week and in different seasons, median PNC was 2.2-fold higher when monitoring was performed downwind of the airport. When PNC spikes from aircraft plumes were observed in real-time during fixed route monitoring, the route was adapted to better capture concentration increases at higher spatial resolution in the plume impact zone. Using this adaptive approach, we observed that median PNC was as much as 4.4-fold higher than background (2 times higher than what we observed using fixed-route monitoring). Finally, based on strategic deployment of a drone equipped with a PNC monitor we were able to delineate PNC plumes aloft (45-60 m) as well as distinguish contributions from individual in-flight aircraft. The results from these combined approaches have proved useful for airport-impact delineation, plume fate and transport, and temporal and spatial variation within impact zones. They have also been useful for identifying locations where ambient and indoor impacts are suspected. To this end, we have monitored several residences in near-airport communities leading to the discovery that both ambient and indoor PNC are significantly elevated when the property is downwind of the airport.

Conclusions. Our results show that stationary-site monitoring in combination with mobile monitoring of UFP near airports yields complementary datasets and more complete characterization of aviation impacts in near-airport communities.

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