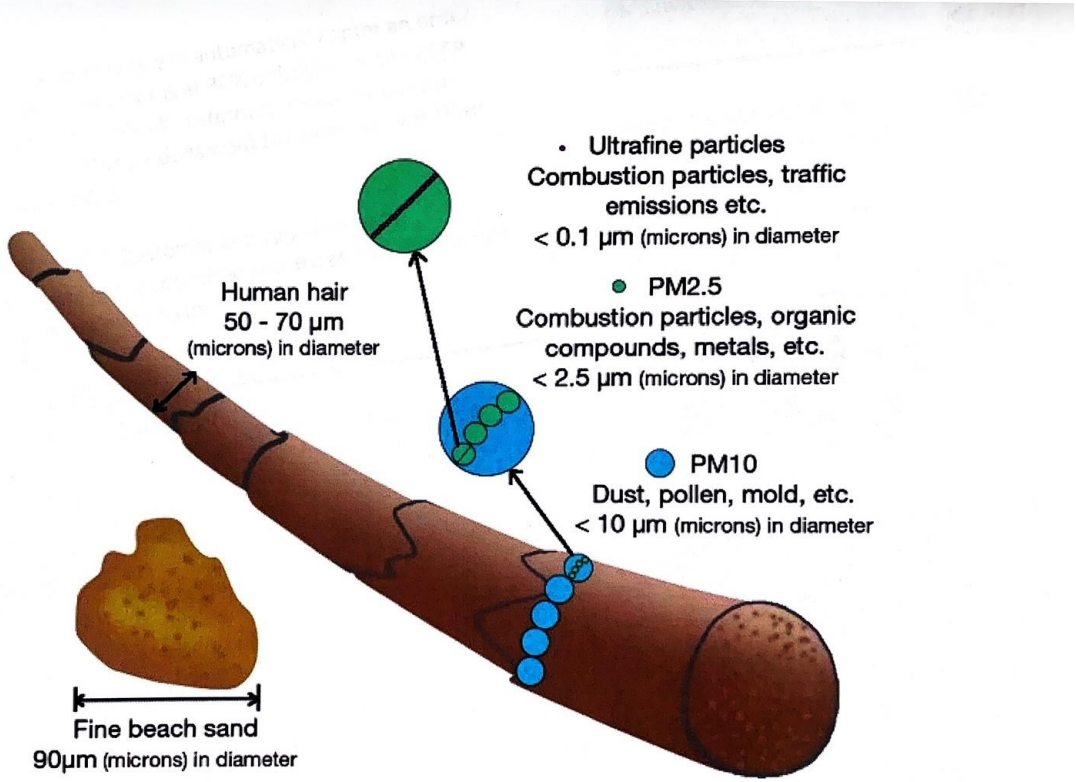
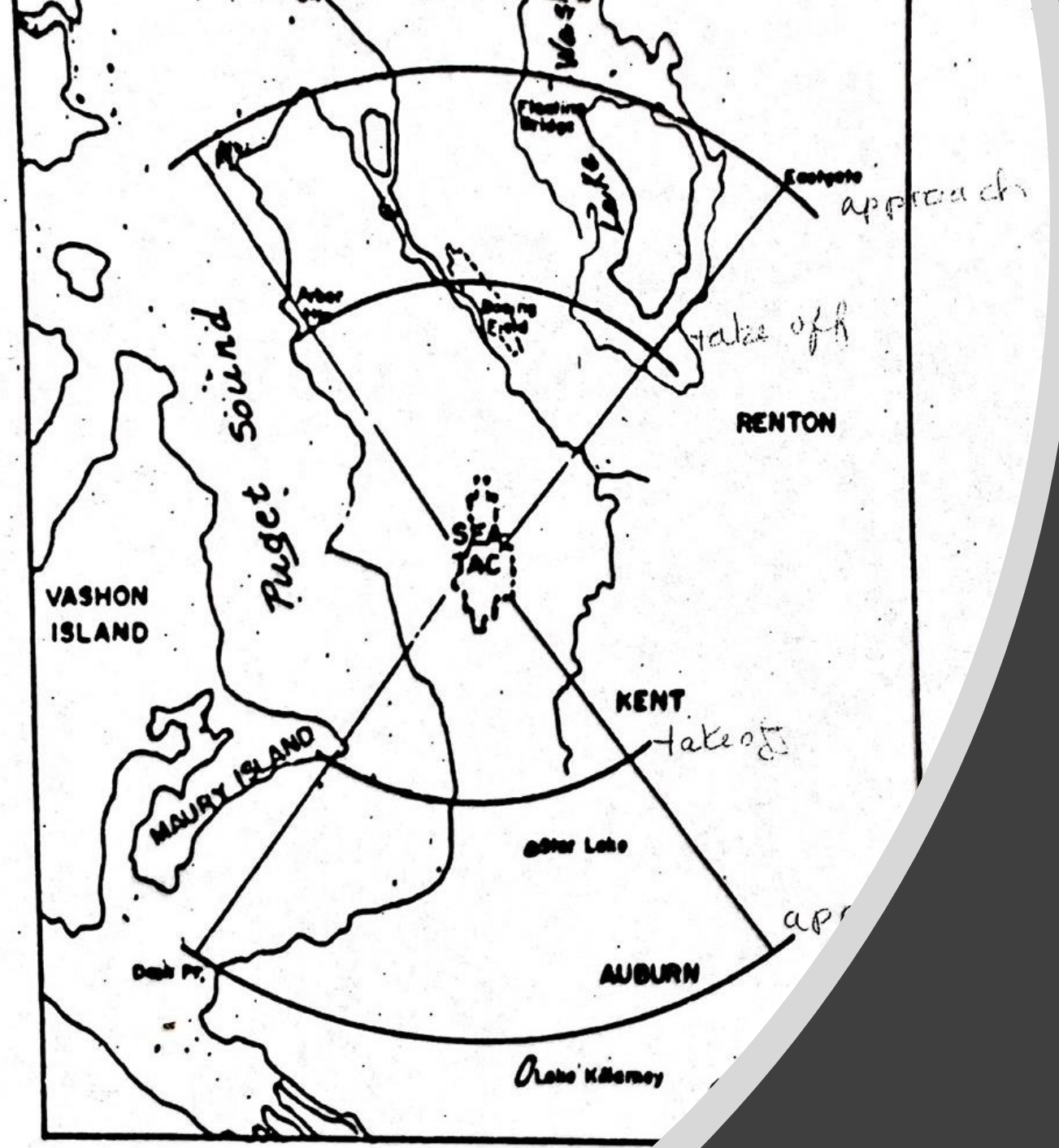
Ultrafine Particles (UFP) Presentation from a community member perspective

- What are UFP
- Discovery process linking overhead aircraft, primarily landing aircraft, to a large impact in densely populated areas in the US
- What are the potential public health effects from UFP?
- What is the observed health status of the exposed population?
- Are there any interventions that reduce the impact?
- Next steps

Size of UFP-Particles-they contribute to atmospheric haze and may be viewed in a mix of larger dark particles on outdoor patios

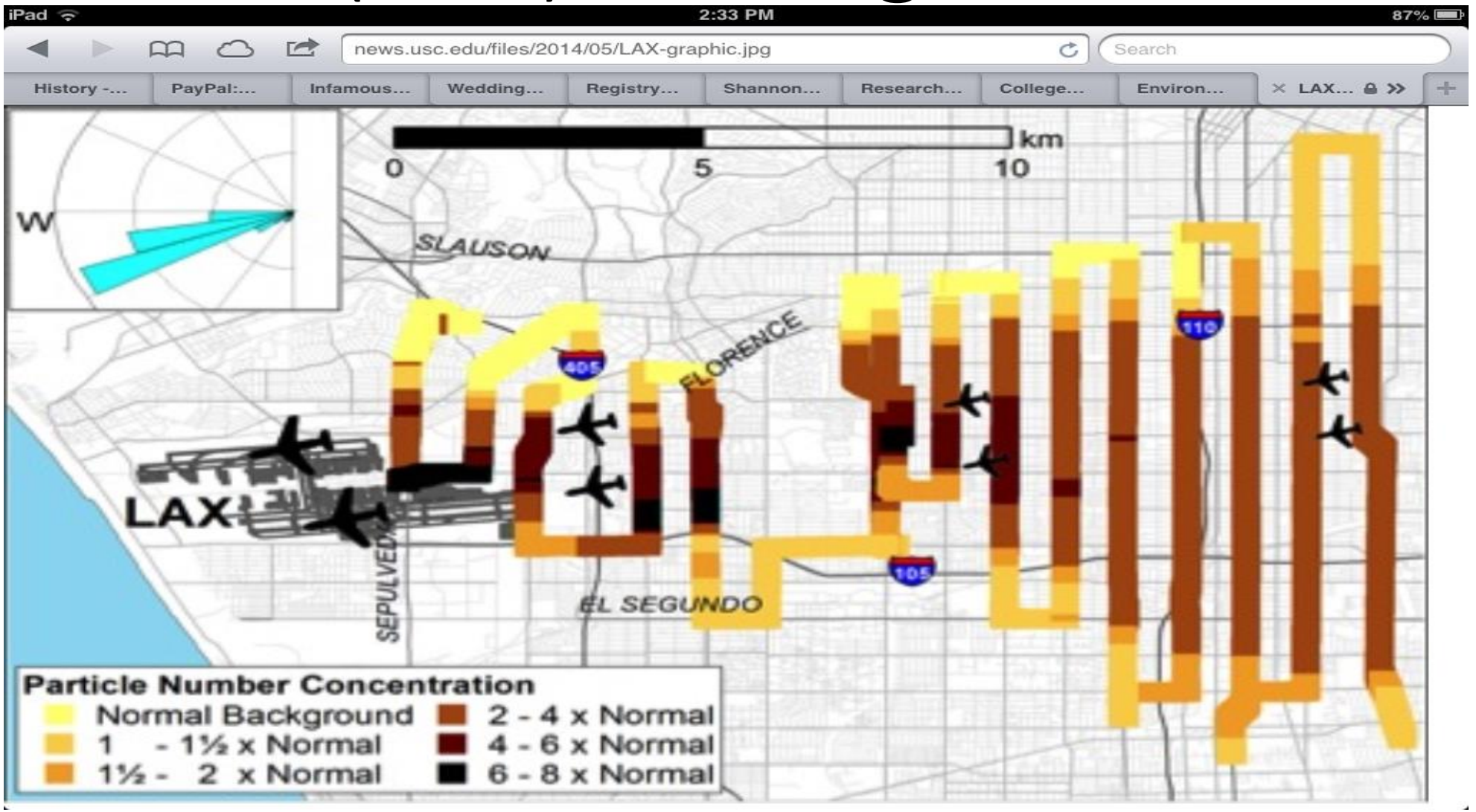




1970 estimate of the size of the particulate plume from Sea-Tac Airport
Particles were detected for 6 miles from runway on takeoff and 12 miles for approach

50 years of ignoring the problem

May 2014 LAX Ultrafine Particle (UFP) Investigation



Riley, et al, LAX/Atlanta 2016

Atmospheric Environment 139 (2016) 20–29

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Ultrafine particle size as a tracer for aircraft turbine emissions

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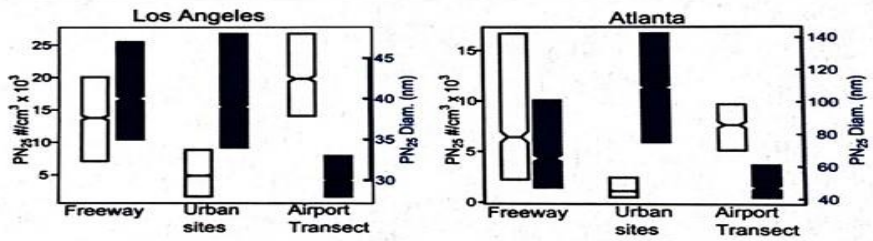
HIGHLIGHTS

- Spatial measurements of ultrafine particle number (PN) and diameter in two cities.
- PN concentrations more than 5 km from airport are similar to those on freeways.
- Spatial distribution of mean ultrafine particle diameter is distinct near airport.
- Ratio of PN to black carbon is higher beneath approach path than elsewhere.

GRAPHICAL ABSTRACT



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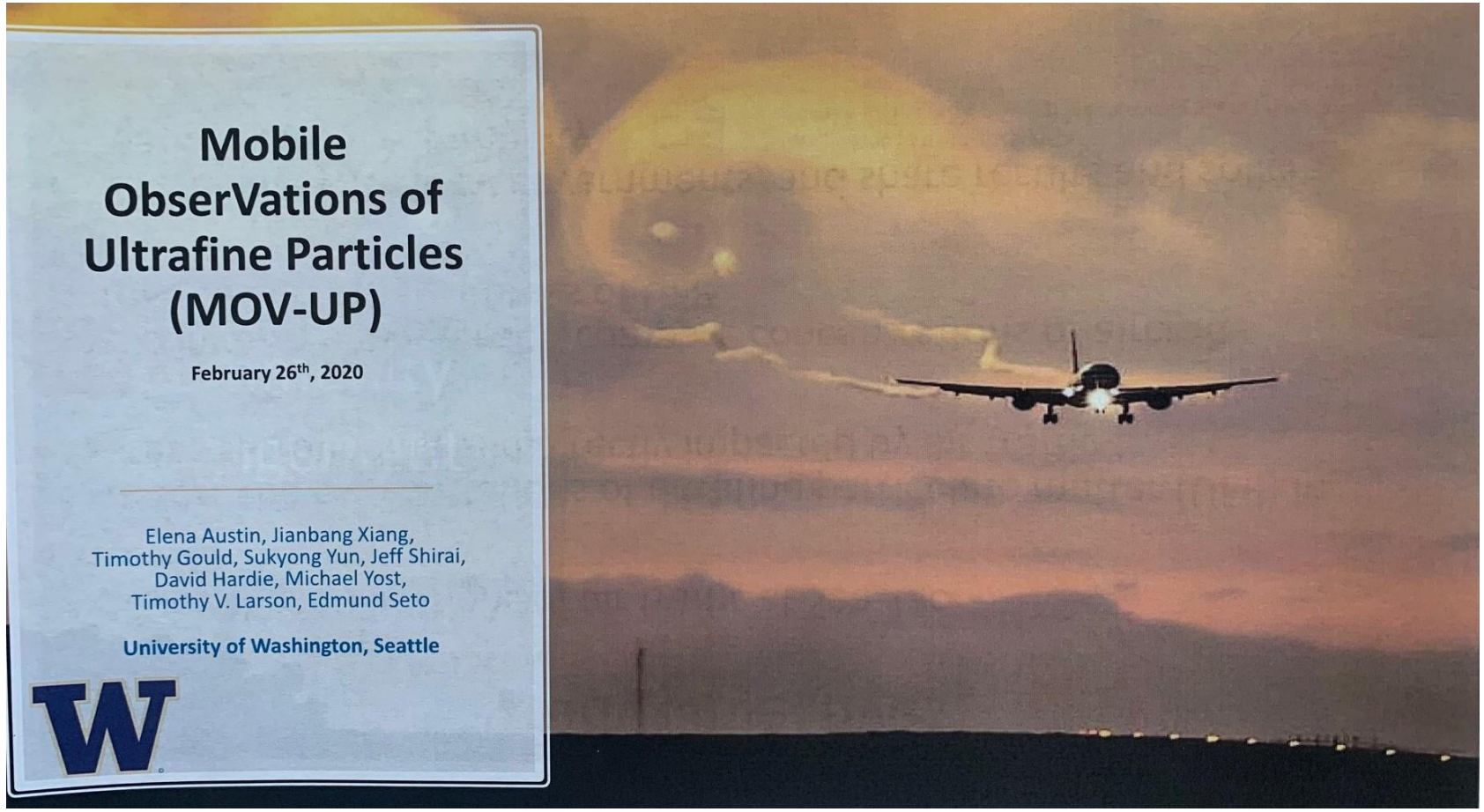
ABSTRACT

Ultrafine particle number (UFPN) and size distributions, black carbon, and nitrogen dioxide concentrations were measured downwind of two of the busiest airports in the world, Los Angeles International Airport (LAX) and Hartsfield-Jackson International Airport (ATL — Atlanta, GA) using a mobile monitoring platform. Transects were located between 5 km and 10 km from the ATL and LAX airports. In addition, measurements were taken at 43 additional urban neighborhood locations in each city and on freeways. We found a 3–5 fold increase in UFPN concentrations in transects under the landing approach path to both airports relative to surrounding urban areas with similar ground traffic characteristics. The latter UFPN concentrations measured were distinct in size distributional properties from both freeways and across urban neighborhoods, clearly indicating different sources. Elevated concentrations of Black Carbon (BC) and NO_2 were also observed on airport transects, and the corresponding pattern of elevated BC was consistent with the observed excess UFPN concentrations relative to other urban locations.

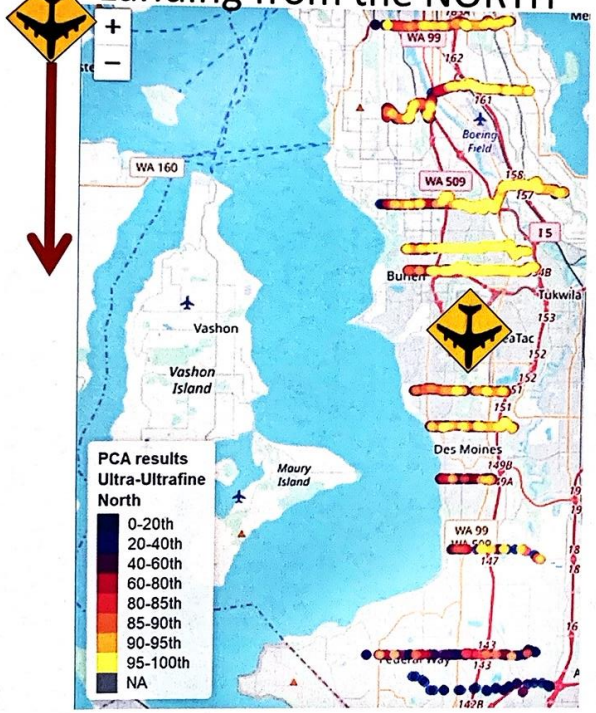
UW Advisory Board-MOV-UP 2016-Present



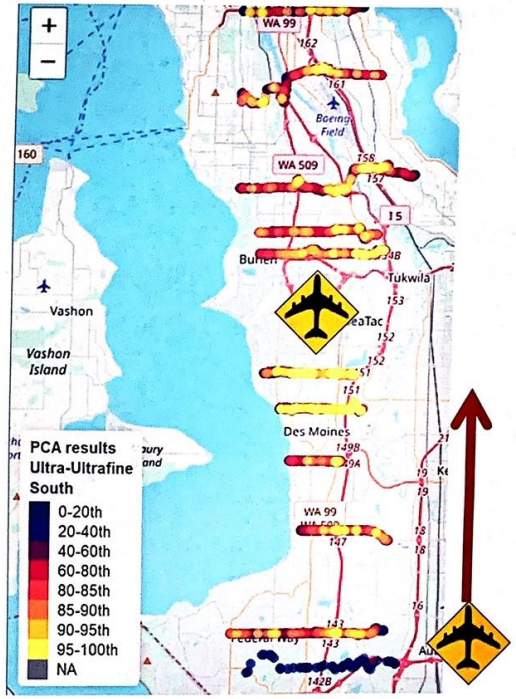
UW UFP Investigation 2016-Present

"Ultra-UFP" tracks landing direction

Landing from the NORTH



Landing from the SOUTH



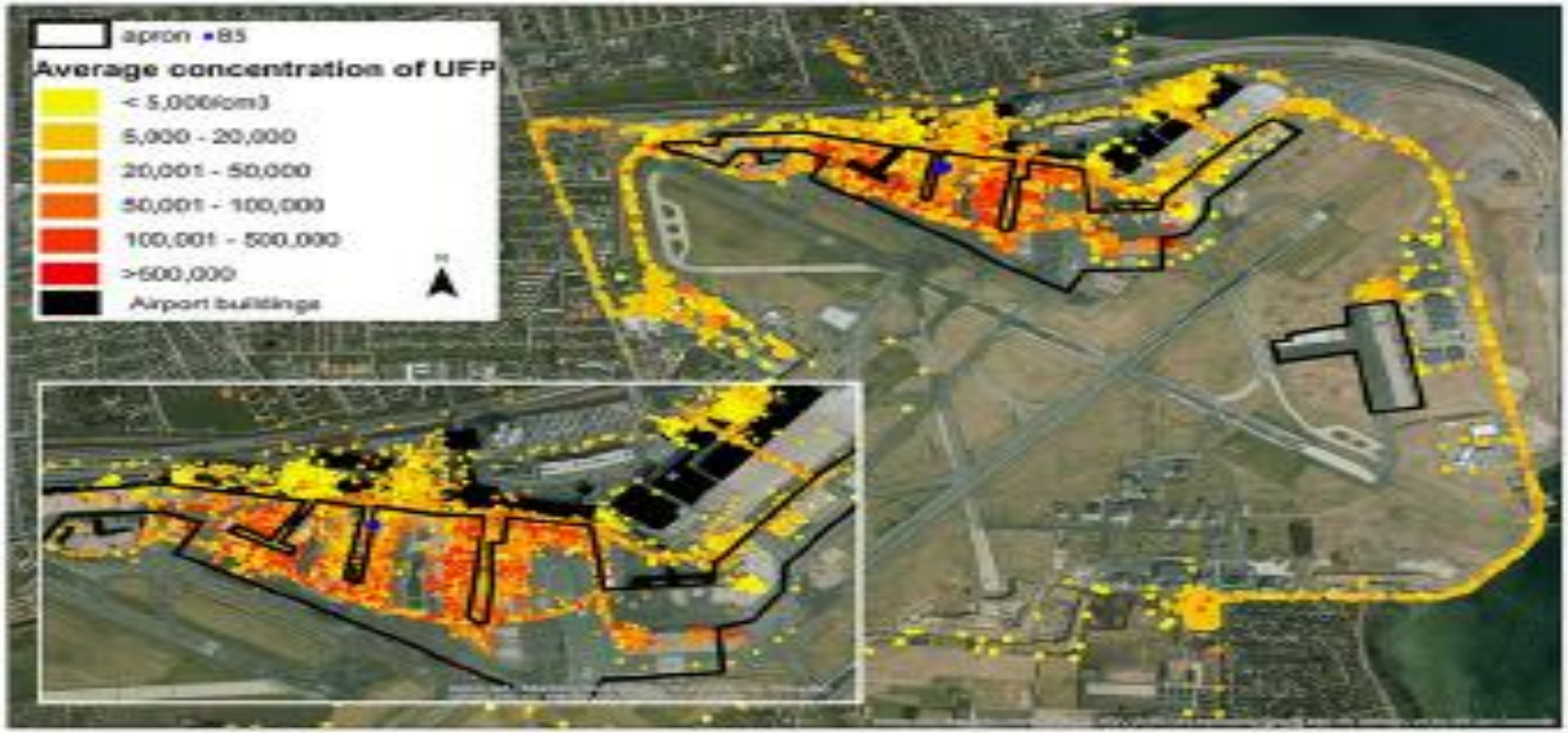
Principle Component Analysis using black carbon

Uniquely small particles, not normally observed in the environment, are emitted from aircraft combustion; hi-bypass, hi-ratio engines developed in the 1980's to reduce carbon monoxide produce more Nox and UFP

Typically, ground transportation produces ultrafine particles in the range of 35-100 nm. Aircraft produce predominately in the range of 10-20 nm. This differentiation means that community investigation of aircraft UFP can differentiate aircraft from ground transportation. The UW team has found the large portion of UFP they see is predominately under the landing path of aircraft. FAA acknowledges aircraft emissions have a ground level impact up to 3,000 feet which covers an area of 10 miles around an airport. And unlike freeways, where residents are removed from the source and larger particles typically coagulate and fall to the ground, aircraft sourced UFP exhibit little coagulation, are primarily affecting residential areas and can drift for many miles.

Due to their extremely small size, UFP can:

- Infiltrate deeply into the lungs
- Cross the membrane barrier and enter the bloodstream potentially affecting all organs and body systems
- Pass up the Olfactory nerve and enter directly into the brain
- Pass through walls and ceilings into homes



Copenhagen

UFP levels on airport property

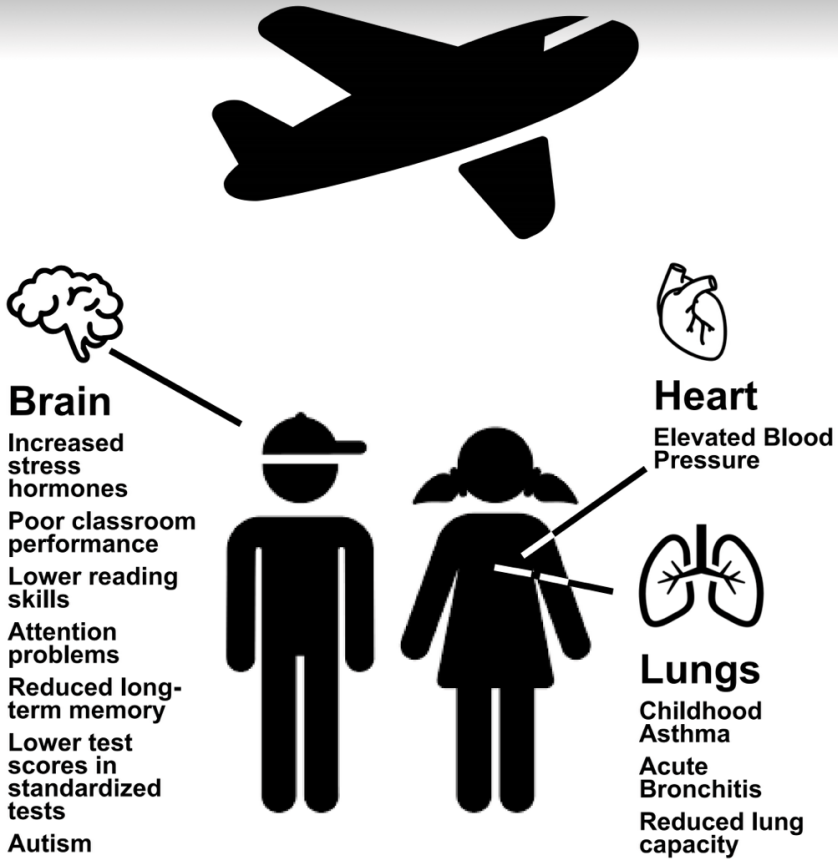
Field test of UFP

- A Park about a half mile north of Sea-Tac Airport downwind with planes landing overhead had readings of 60,000 parts UFP per cm^3
- Freeway levels range in this number. When the wind shifted the level dropped to 20-30,000 which is higher than average but more in line with typical background levels in the urban area
- Next to the airport terminal the reading was 117,000 approx. similar to Copenhagen but in an area of public exposure that can have an effect on people with respiratory problems. Inside the terminal building the level was 4,500 indicating great improvement in air quality due to filtration
- Nobody would be healthy for long living on a lane of freeway or working on an airfield but most people are largely unaware of this large plume of pollution.
- Jet engines were modified to burn hotter in the 1980-90's to reduce emissions of carbon monoxide. However, in turn, this created smaller particles and significantly more NOx. It was unknown at the time whether one pollutant traded for another would be as or more harmful.

UW Modeled Plume

Ultrafine Particles, not regulated like larger particles but potentially more dangerous

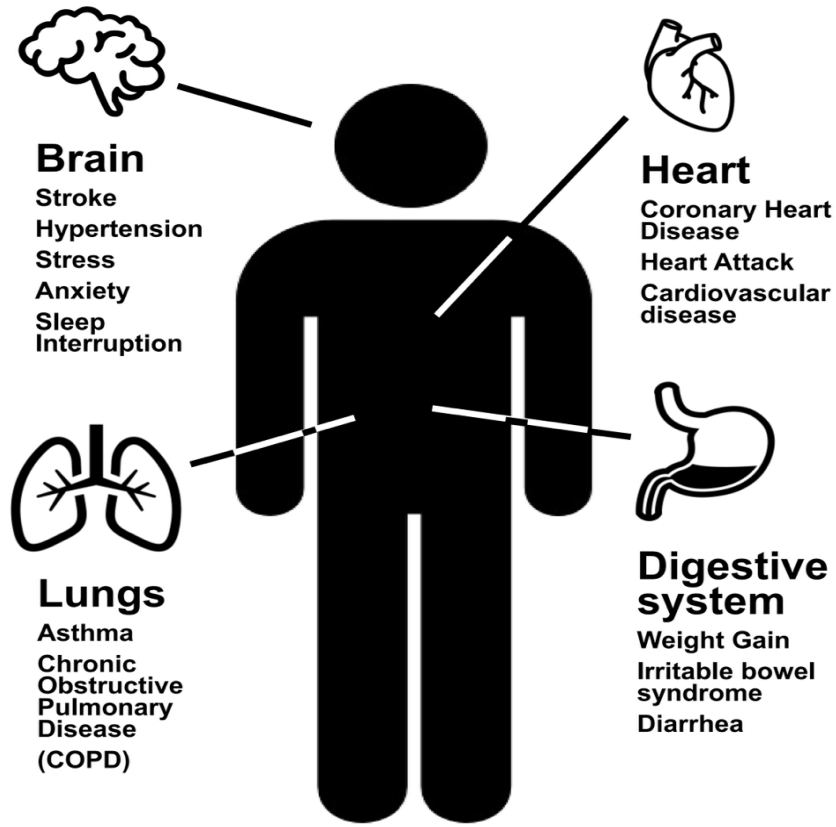
- **What are ultrafine particles?**
- Ultrafine particles are defined as particulate matter smaller than 0.1 microns in diameter.[3] They're mostly generated by combustion reactions that are used to power vehicle engines, industrial facilities, diesel-powered trucks, and aviation engines.
- Current government air quality regulations and standards do not cover UFPs, yet these tiny contaminants may account for more than 90% of all airborne pollution particles.[4]
- Ultrafine particles are associated with:
- - **asthma**[5]
  - **allergies**[6]
  - **respiratory disease**[7]
  - **heart attacks**[8]
  - **strokes**[9]
  - **cancer**[10]
- **Ultrafine particle levels higher than typical near airports**
- UFPs have been found in especially high levels near airports, where airplane engines produce high concentrations of UFPs as they fly across nearby cities and neighborhoods.
- A series of studies commissioned by airport officials and conducted by third-party researchers in the past decade has gradually uncovered that the air quality around the Los Angeles International Airport was not much different from the air quality generally in the region, except for one area of concern: ultrafine particles.[11,12,13]
- These studies reported that ultrafine particle concentrations east of the airport were especially higher than typical levels.
- Airport officials have continuously pledged to continue studying ultrafine particle levels in the wake of these results.
- But you may be wondering: why would ultrafine particle concentrations be rising even when the level of other airborne pollutants seems to be under control?
- Mike Feldman, former Los Angeles World Airports deputy executive director (now retired), noted that the fuel-burning technology that has made jet aircraft more fuel efficient in recent years also produces smaller particles than before.
- "It's something that science doesn't know much about," Feldman has expressed to local newspapers.[14]



What can airport noise and pollution do to children?

See the Airport Impacts Health Forum Video Presentations
Watch Destination: East Boston documentary on Logan Impacts
Learn about the real-time online air quality monitoring project
Join the conversation at AIR, Inc on Facebook

Airport Impact Relief, Incorporated (AIR, INC.)



What is airport noise and air pollution costing YOU?

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Airport Impact Relief, Incorporated (AIR, INC.)

Emerging Science: Association between Airport–Related Ultrafine Particles and Risk of Malignant Brain Cancer: A Multiethnic Cohort Study

- Cox proportional hazards models were used to estimate the effects of time-varying, airport-related UFP exposure on risk of malignant brain cancer and meningioma, adjusting for sex, race/ethnicity, education, and neighborhood socioeconomic status. Malignant brain cancer risk in all subjects combined increased 12% [95% confidence interval (CI), 0.98-1.27] per interquartile range (IQR) of airport-related UFP exposure (~6,700 particles/cm^3) for subjects with any address in the grid area surrounding the LAX airport.
- These results support the hypothesis that airport-related UFP exposure may be a risk factor for malignant brain cancers. SIGNIFICANCE: Malignant brain cancer risk increases with airport-related UFP exposure, particularly among African Americans, suggesting UFP exposure may be a modifiable risk factor for malignant brain cancer.

Headlines for health effects of UFP

- **Air Pollution, Ultrafine Particles, and Your Brain**:

Are Combustion Nanoparticle Emissions and Engineered Nanoparticles Causing Preventable Fatal Neurodegenerative Diseases and Common Neuropsychiatric Outcomes?

- **Fine particulate matter exposure during childhood relates to hemispheric-specific differences in brain structure**

- **Health effects of ultrafine particles: a systematic literature review update of epidemiological evidence**

Conclusions: The evidence suggests adverse short-term associations with inflammatory and cardiovascular changes, which may be at least partly independent of other pollutants

Headlines, cont.

- "Aviation Emissions Impact Ambient Ultrafine Particle Concentrations in the Greater Boston Area." https://pubs.acs.org/doi/pdf/10.1021/acs.est.6b01815

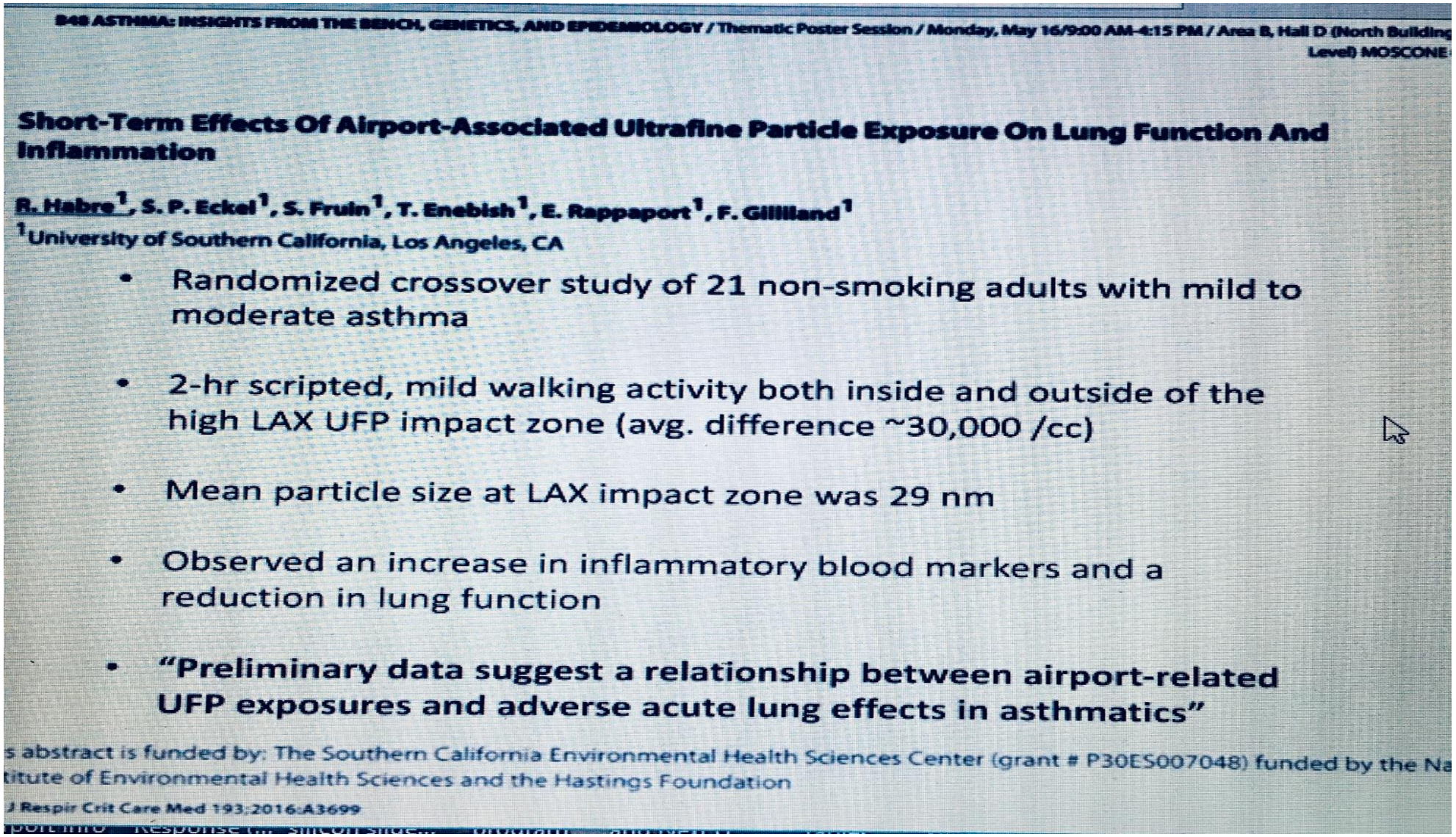
- "An air quality study has for the first time detected nano-sized particles of air pollution in children's urine…these ultrafine particles are the smallest particles found in air pollution and have been linked to heart disease and respiratory conditions in previous studies.

- The research provides the first direct evidence that some of the particulate matter known as black carbon that we inhale in soot and fumes is making it across the lung barrier and into the body's circulatory system." https://horizon-magazine.eu/article/ultrafine-pollution-particles-create-air-menace_en.html

Story on LAX UFP study

- “High levels of potentially harmful exhaust particles from jets using Los Angeles International Airport have been **detected in a broad swath of densely populated communities up to 10 miles east of the runways**…The research, believed to be the most comprehensive of its type, found that takeoffs and landings at LAX are a major source of ultrafine particles. They are being emitted over a larger area than previously thought, the study states, and **in amounts about equal in magnitude to those from a large portion of the county’s freeways**…The findings raise health concerns, researchers say, because the minute particles, which result from the condensation of hot exhaust vapor from cars, diesel trucks and aircraft, have the **potential to aggravate heart and lung conditions, including asthma and the development of blocked arteries**.”
https://www.change.org/p/stop-the-faa-nextgen-flights-over-culver-city/u/22489687?recruiter=false&utm_source=share_update&utm_medium=facebook&utm_campaign=facebook_link

Walking in a flight path



Short-Term Effects Of Airport-Associated Ultrafine Particle Exposure On Lung Function And Inflammation

R. Habre[1], S. P. Eckel[1], S. Fruin[1], T. Enebish[1], E. Rappaport[1], F. Gilliland[1]
[1]University of Southern California, Los Angeles, CA

- Randomized crossover study of 21 non-smoking adults with mild to moderate asthma
- 2-hr scripted, mild walking activity both inside and outside of the high LAX UFP impact zone (avg. difference ~30,000 /cc)
- Mean particle size at LAX impact zone was 29 nm
- Observed an increase in inflammatory blood markers and a reduction in lung function
- **"Preliminary data suggest a relationship between airport-related UFP exposures and adverse acute lung effects in asthmatics"**

s abstract is funded by: The Southern California Environmental Health Sciences Center (grant # P30ES007048) funded by the Na
titute of Environmental Health Sciences and the Hastings Foundation

Next obvious question: What is the health status of people inside the plume: A 2020 investigation

King County observed health outcomes

- 670,000+ living in the plume area
- Nearly ¼ of the county's 2.3 million people population potentially affected.
- An exam of US airports found that approximately 10% of the total population is living within 10 miles of a major airport-33 million potentially affected
- Unlike freeways, there are no mitigations for aircraft exhaust which falls primarily onto residents

Observed health status of people in the plume

Airport communities are associated with higher rates of pervasive health concerns. Compared to the rest of the county, communities within 10 miles of SeaTac report:

- A greater percentage of infants born prematurely and/or with low birthweight;
- Higher hospitalization rates for asthma, stroke, chronic obstructive pulmonary disease (COPD), heart disease, and diabetes;
- Lower life expectancy; and
- Higher rates of death overall, as well as death from heart disease, unintentional injury, chronic lower respiratory disease, diabetes, chronic liver disease, and homicide.

In several measures, the rates of poor health outcomes were worse the closer you are to the airport. For example:

- Higher hospitalization rates for heart disease;
- Higher rate of death from all causes;
- Higher rate of death from heart disease; and
- Lower life expectancy.

This examination of community health is a snapshot of health conditions experienced by people living within 10 miles of SeaTac airport. Findings demonstrate that disparities are present throughout the life course, beginning at birth.

Indoor infiltration of aircraft sourced UFP

Environmental Science & Technology

ACS Editors' Choice

Article

Cite This: *Environ. Sci. Technol.* 2018, 52, 1765−1772

pubs.acs.org/est

Aviation-Related Impacts on Ultrafine Particle Number Concentrations Outside and Inside Residences near an Airport

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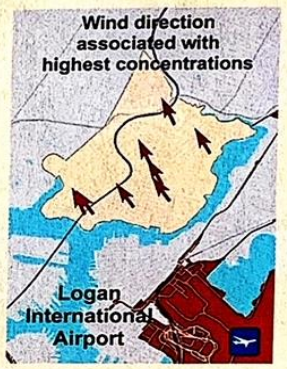
Supporting Information

ABSTRACT: Jet engine exhaust is a significant source of ultrafine particles and aviation-related emissions can adversely impact air quality over large areas surrounding airports. We investigated outdoor and indoor ultrafine particle number concentrations (PNC) from 16 residences located in two study areas in the greater Boston metropolitan area (MA, USA) for evidence of aviation-related impacts. During winds from the direction of Logan International Airport, that is, impact-sector winds, an increase in outdoor and indoor PNC was clearly evident at all seven residences in the Chelsea study area (~4−5 km from the airport) and three out of nine residences in the Boston study area (~5−6 km from the airport); the median increase during impact-sector winds compared to other winds was 1.7-fold for both outdoor and indoor PNC. Across all residences during impact-sector and other winds, median outdoor PNC were 19 000 and 10 000 particles/cm^3, respectively, and median indoor PNC were 7000 and 4000 particles/cm^3, respectively. Overall, our results indicate that aviation-related outdoor PNC infiltrate indoors and result in significantly higher indoor PNC. Our study provides compelling evidence for the impact of aviation-related emissions on residential exposures. Further investigation is warranted because these impacts are not expected to be unique to Logan airport.



Relationship between high UFP and pre-term births LAX

Preterm Birth among Infants Exposed to in Utero Ultrafine Particles from Aircraft Emissions Sam E. Wing,1 Timothy V. Larson,2 Neelakshi Hudda,3* Sarunporn Boonyarattaphan,2 Scott Fruin,4* and Beate Ritz1* 1 Department of Epidemiology, University of California, Los Angeles, Los Angeles, California, USA 2 Departments of Civil & Environmental Engineering and Occupational & Environmental Health Sciences, University of Washington, Seattle, Washington, USA 3 Department of Civil & Environmental Engineering, Tufts University, Medford, Massachusetts, USA 4 Division of Environmental Health, University of Southern California, Los Angeles, California, USA INTRODUCTION:

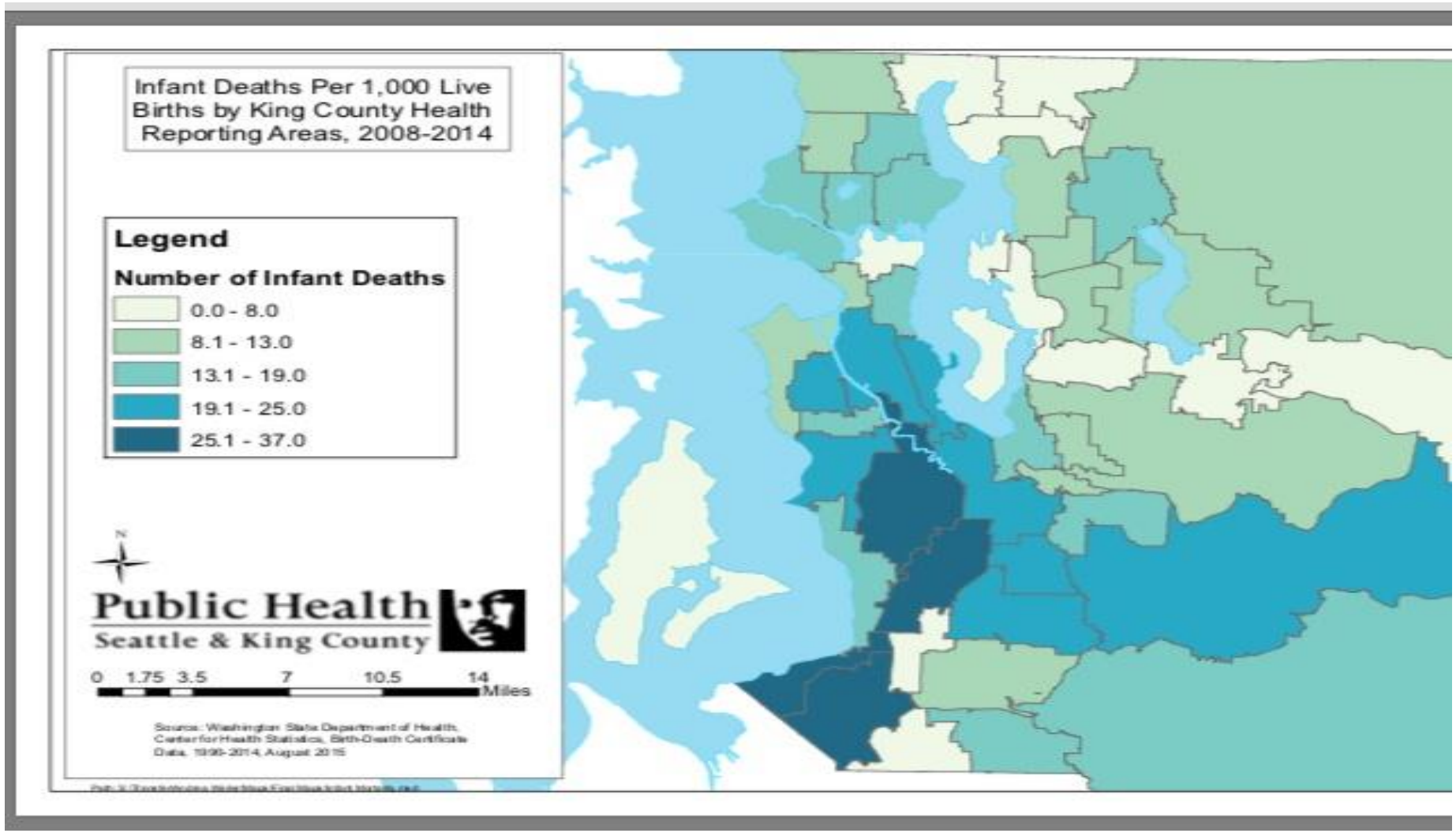
Ambient air pollution is a known risk factor for adverse birth outcomes, but the role of ultrafine particles (UFPs) is not well understood. Aircraft-origin UFPs adversely affect air quality over large residential areas downwind of airports, but their reproductive health burden remains uninvestigated. OBJECTIVES: This analysis evaluated whether UFPs from jet aircraft emissions are associated with increased rates of preterm birth (PTB) among pregnant mothers living downwind of Los Angeles International Airport (LAX).

CONCLUSION: Our results suggest that emissions from aircraft play an etiologic role in PTBs, independent of noise and traffic-related air pollution exposures. These findings are of public health concern because UFP exposures downwind of airfields are common and may affect large, densely populated residential areas. https://doi.org/10.1289/EHP5732

Relationship between high noise (55 db) levels near Newark and low-birth weight

- Now, for the first time, researchers have provided a causal estimate linking high-level noise exposure to another key health challenge: low birth weight (< 2,500 grams or approximately 5.5 pounds).
- Health economists from Lehigh University, Lafayette College and the University of Colorado, Denver were able to pinpoint a causal link by studying residential neighborhoods impacted by recent changes in airplane flight patterns going in and out of Newark Liberty International Airport, one of the largest airports in the United States.
- https://medicalxpress.com/news/2020-07-airplane-noise-negatively-impact-fetal.html

Dramatic infant mortality rates in flight-path for Sea-Tac Airport



UW MOV-UP Healthy Air/Healthy Schools Intervention/mitigation

- The Healthy Air, Healthy Schools Project is measuring and identifying sources of ultrafine pollution particles in classrooms in urban and rural settings in Washington to investigate the impacts of improving air quality in schools. The study is led by the University of Washington Department of Environmental & Occupational Health Sciences (DEOHS).
- Phase 1 of the study, completed in December 2021, found that ultrafine air pollution particles from road and aircraft traffic infiltrate schools around Seattle-Tacoma International Airport, with potential negative effects on health and student academic performance. Using HEPA air purifiers significantly improved classroom air quality.

What are some mitigation measures to reduce indoor exposure

Phase 1 of the study, completed in December 2021, found that ultrafine air pollution particles from road and aircraft traffic infiltrate schools around Seattle-Tacoma International Airport, with potential negative effects on health and student academic performance. Using HEPA air purifiers significantly improved classroom air quality.

The study found that about one-half of all outdoor ultrafine pollution was measured inside classrooms in five schools near the airport before HEPA air purifiers were installed. Measurements after the HEPA units were deployed found that ultrafine pollution in classrooms dropped to about one-tenth of outdoor levels.

Next Steps

- **Background**
- The recently completed Mobile ObserVations of Ultrafine Particles Study (MOV-UP) demonstrated extensive and distinct geographic impact of ultrafine particles (UFP) from aircraft and on-road activity for communities within a 10-mile radius of the Seattle-Tacoma International Airport. A key finding of this project was that the size distribution and multipollutant features of on-road and aircraft sources were characteristically and significantly different. Developing methods to collect and characterize size-fractioned ambient UFP addresses this important gap while developing the internal University of Washington Department of Environmental and Occupational Health capacity to characterize nano-sized particles in both environmental and occupational settings.
- **Proposed Methods**
- In cooperation with community partners and stakeholders, a near-airport and near-roadway site will be selected for sample collection. At each site, samples will be collected over a 2-week period. Sampling will be repeated at each site over 4 seasons. Analysis of the size-fractioned samples will provide a spectral representation of the metal content across particles ranging in size from 16 nm – 10 um.
- **Project Outcomes**
- This project is structured to ensure continued engagement of community groups and stakeholders, validate a novel collection and analysis approach for urban nanoparticles and engage researchers across the University of Washington with an interest in ultrafine particle exposures and health impacts in order to identify novel solutions and research strategies.

References

- UW MOV-UP

https://deohs.washington.edu/mov-up

- Health in Aviation Impacted Communities

Community Health and Airport Operations Related Pollution Report.pdf