Airports and issues of air quality

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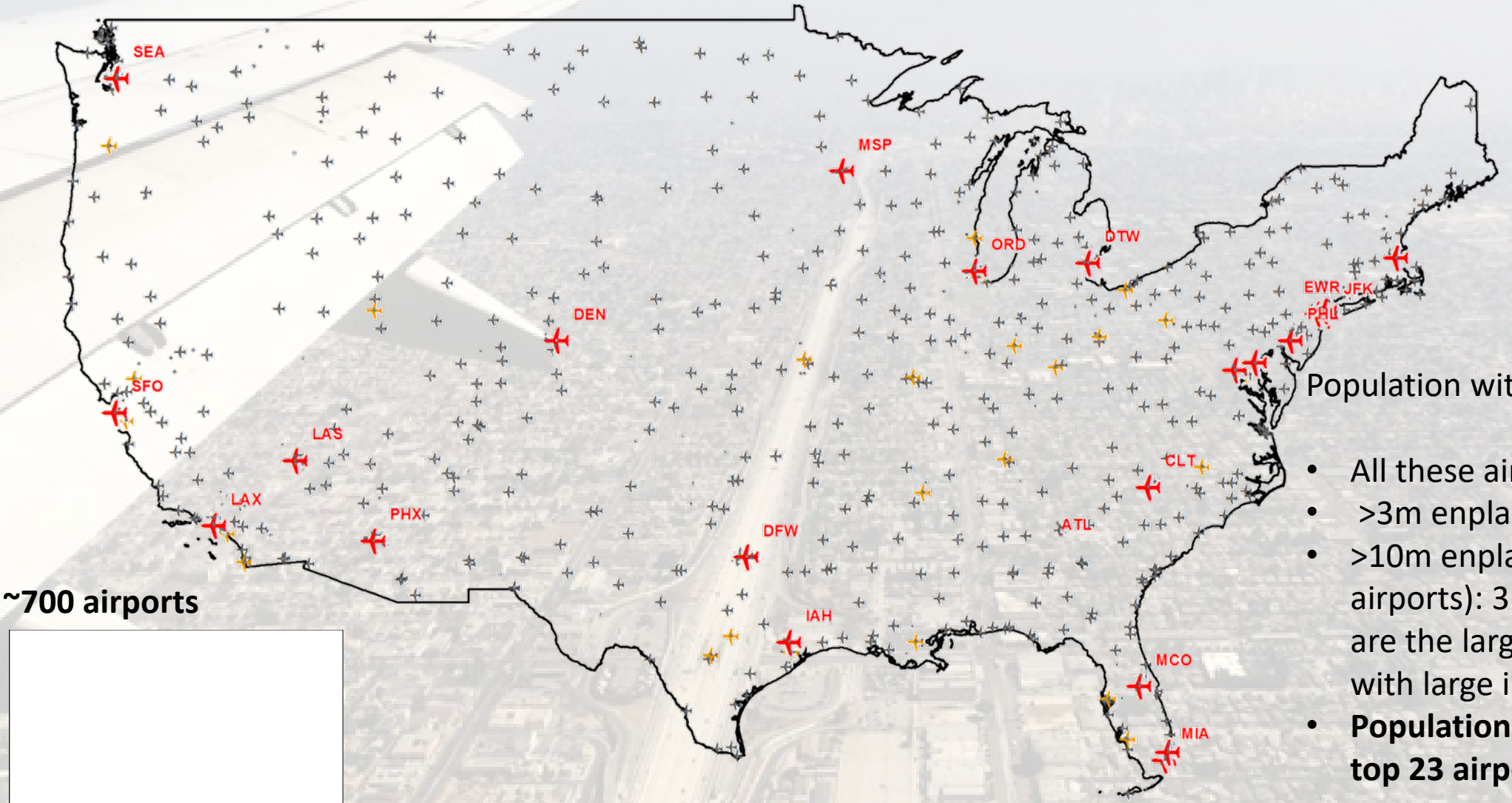
Outline of the presentation

- Environmental Justice metrics for near-airport communities
- Why are ultrafine particles a common focus of most of the current aviation-related air quality work?
- Latest health associations specific to these ultrafine exposures
- Generalizable findings for characterization studies
  - Large spatial extent & Indoor intrusion
- Current issues in advancing the findings
  - GAA, Scaling and generalizing, and lastly policy.

Large populations reside near airports in US



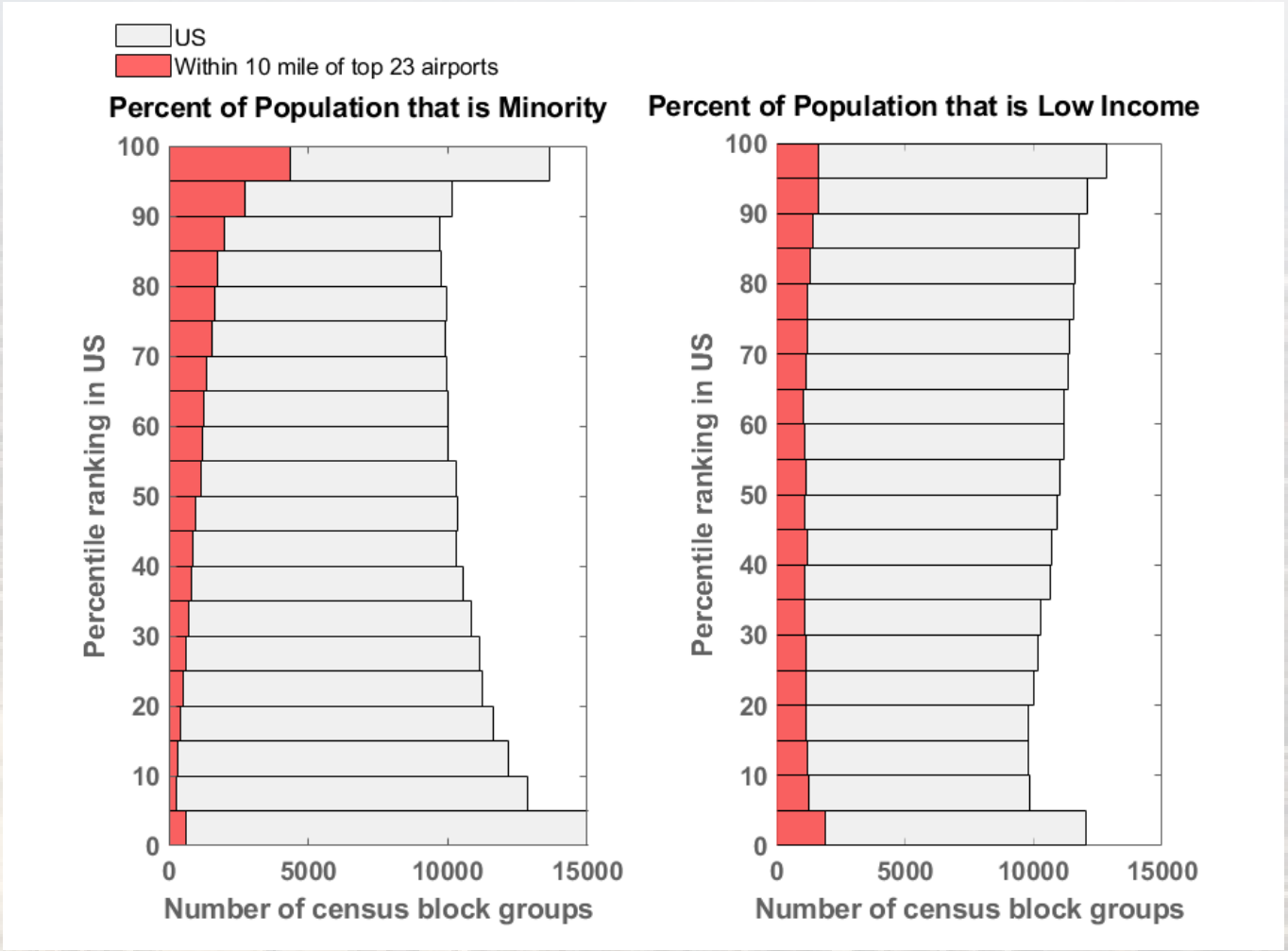
~700 airports

Population within 3 miles of

- All these airports: 34 million
- >3m enplanements: 6.2 million
- >10m enplanements (23 airports): 3.2 million BUT these are the largest of the airports with large impact zones!
- **Population within 10 miles of top 23 airports: 33.3 million**

Near-airport communities rank high on environmental justice metrics

- Disproportionately higher fraction of minority populations live near airports.



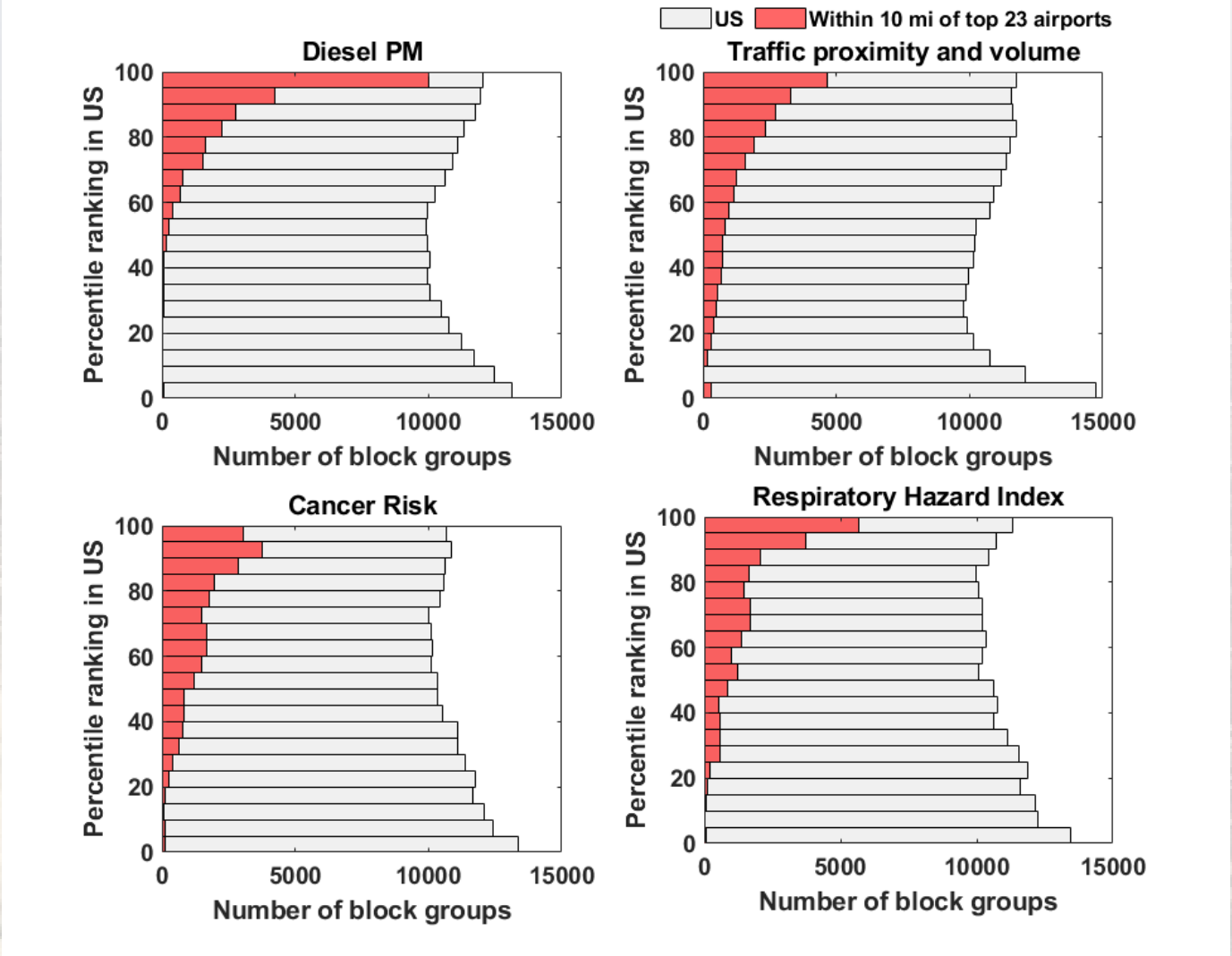
https://www.epa.gov/ejscreen

Near-airport communities rank high on environmental justice metrics

- Near-airport environmental indicators:

Disproportionately

- ✓ Higher concentrations of ambient diesel PM;
- ✓ Closer proximity to traffic and higher traffic volume;
- ✓ Greater lifetime cancer risk from inhalation of air toxics ;
- ✓ Higher air toxics respiratory hazard index (ratio of exposure concentration to health-based reference concentration)



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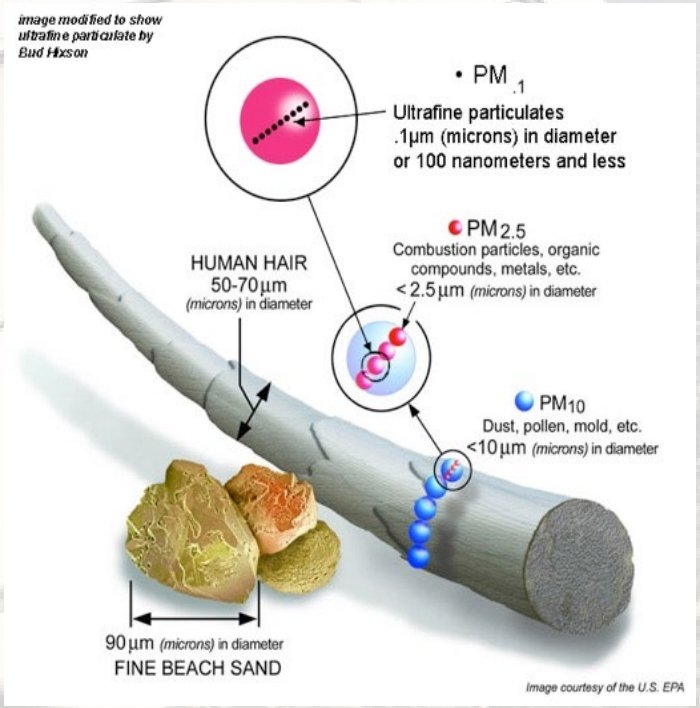
Air Pollutant Of High Interest

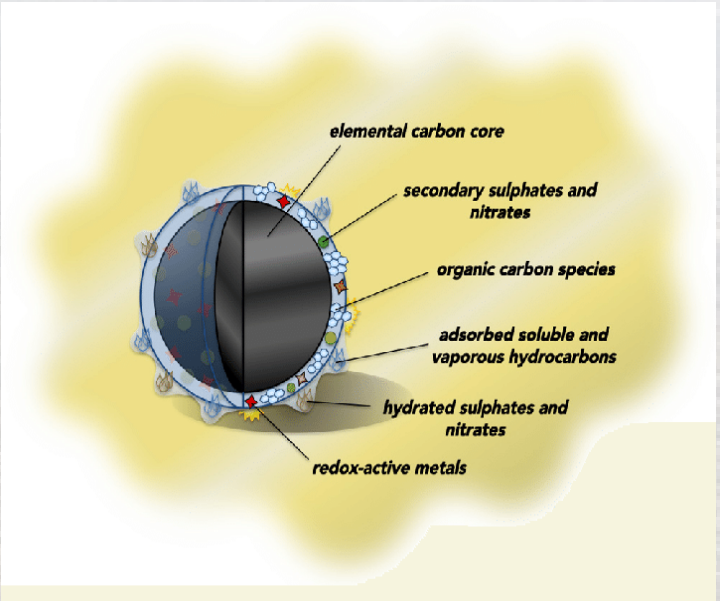
Ultrafine Particles: **Number And Size Are Used As Markers Of Fuel Combustion**



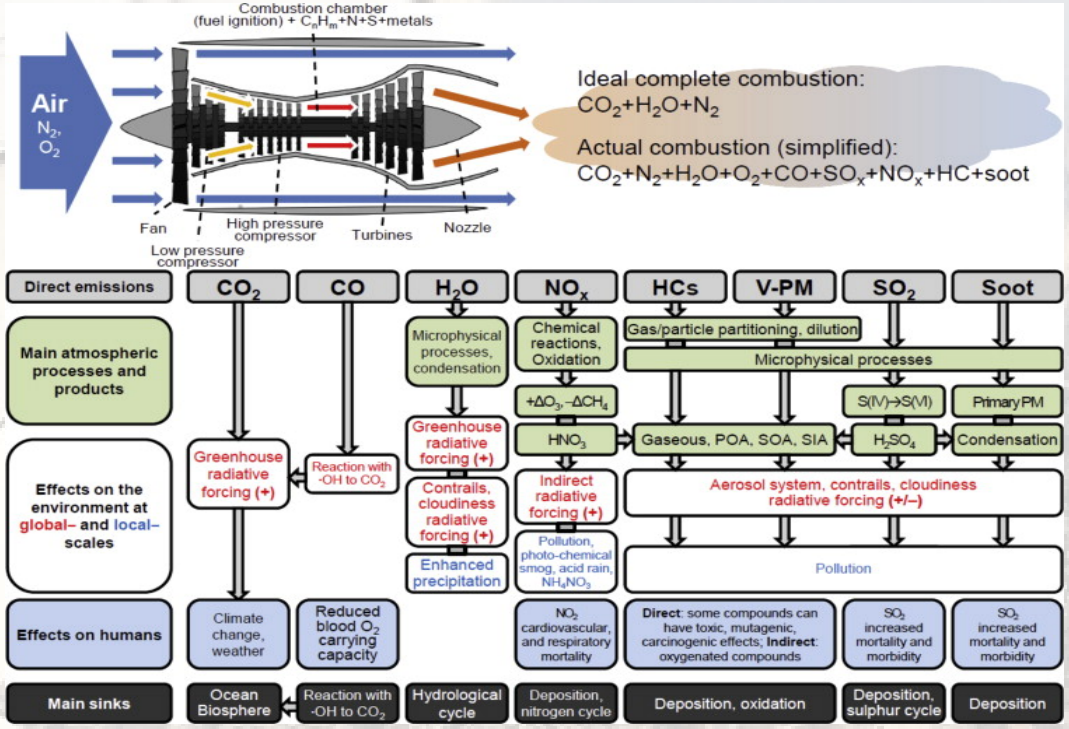
Sizes of particulate matter compared to human hair and beach sand. Illustration: Eda Lu, based on US EPA "Particulate Matter (PM) Pollution" from the book "Particles in the Air" https://now.tufts.edu/articles/toxic-air-we-breathe

Ultrafine particles:

- ❑ smaller than 100 nm
- ❑ reported as a count in one cm^3
- ❑ markers of fuel combustion emissions
- ❑ emitted in huge numbers by jet planes!



Airplane Exhaust Is A Complex Mixture Of Pollutants



Masiol et al., 2014, Atmospheric Environment

Ultrafine particles

- ❑ It is ONE physical, size-based lens to look at this complex mixture.
  There is some very involved chemistry in size distribution, chemical composition, plume dynamics and evolution!
- ❑ But, it is a physical form of pollution that is abundantly present near airports because it is abundantly emitted from airplanes.
- ❑ Excellent proxy for understanding spatial zone associated with ground-level impacts

Adverse health conditions have higher incidence in near-airport communities

Exposure to **elevated levels air pollution (and noise) from aircrafts** near airports is associated with increased rates of

- ❑ hypertension
- ❑ hypertensive medication prescriptions
- ❑ cardiovascular disease
- ❑ cardiovascular disease-related hospitalization
- ❑ adverse learning outcomes in children
- ❑ pre-term birth
- ❑ brain cancer

Preterm birth rates among mothers exposed to ultrafine particles from jet exhaust (Wing et al. EHP, 2020):

- The highest quartile of pregnancy-average UFP exposure was associated with a 1.32 (CI: 1.27-1.39) odds ratio (OR)* in comparison with the lowest quartile.

- Controlling for covariates (demographic risk factors, traffic pollution and noise) the OR for PTB in the highest quartile of UFP exposure was 1.14 (CI: 1.08-1.20) compared to lowest.

**The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. Szumilas M. 2015 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2938757/*

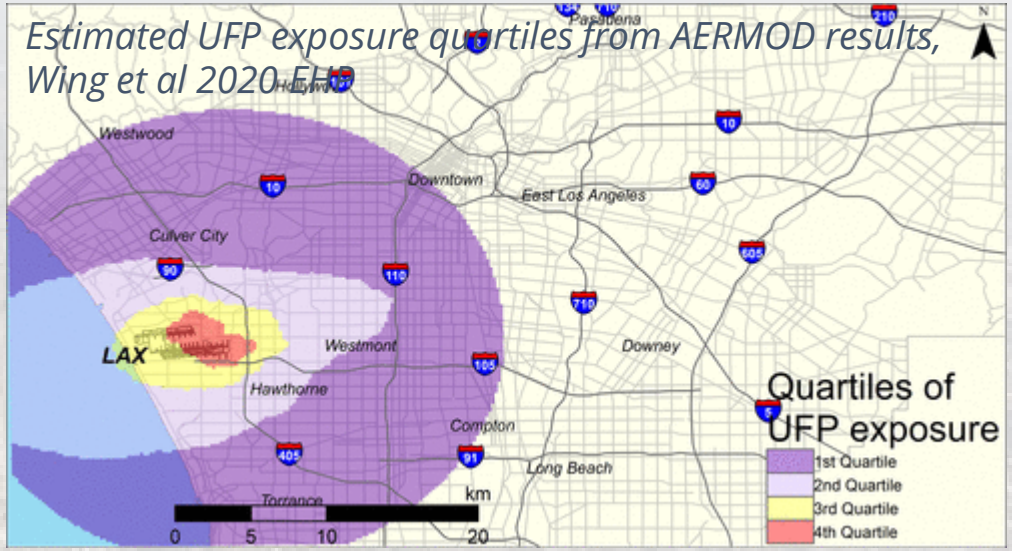
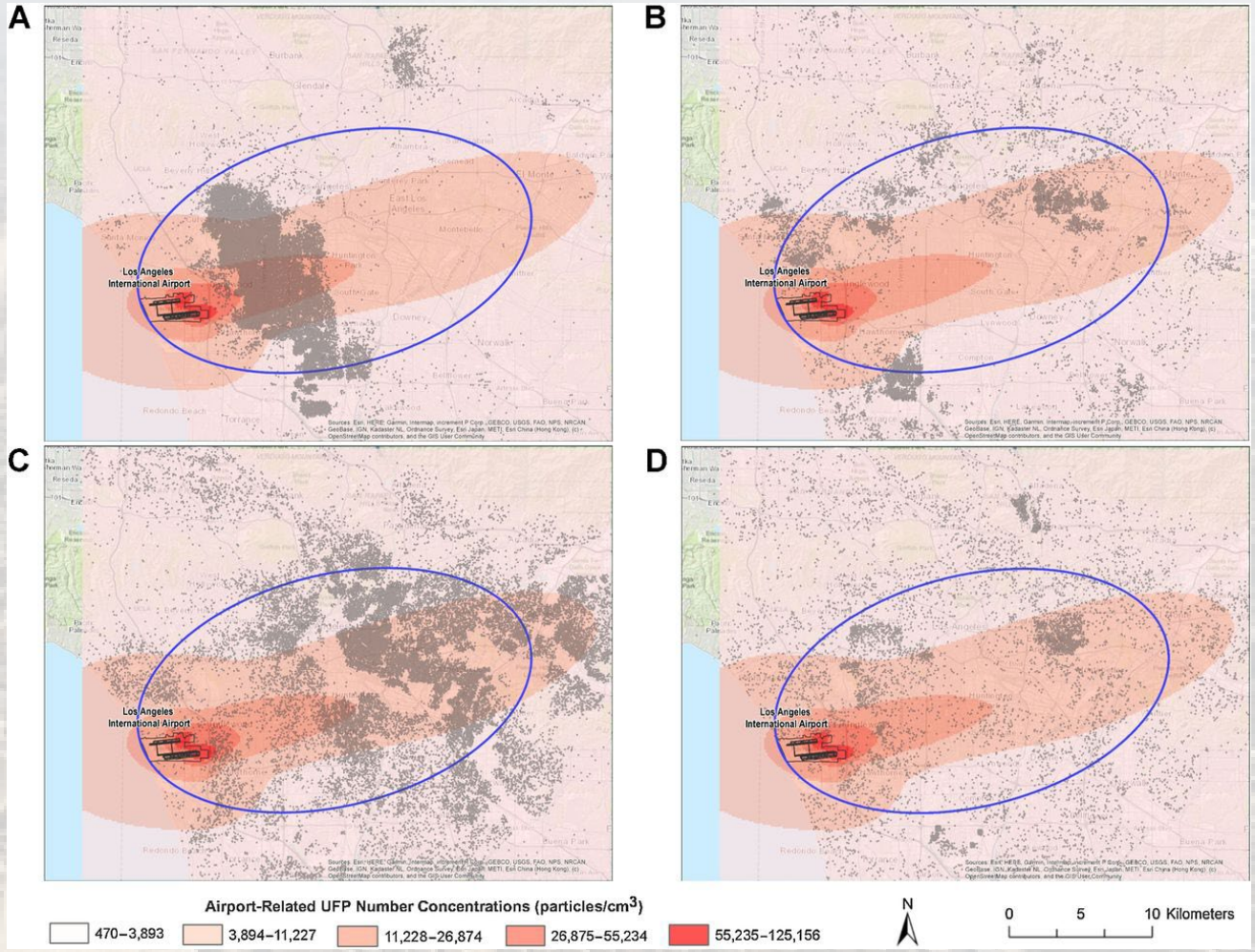


Table 2. Adjusted odds ratios (ORs) [95% confidence intervals (CIs)]

Variable	Unadjusted model	Adjusted model 3[d]
UFP		
Quartile 1 (<5,340 particles/cc)	Ref	Ref
Quartile 2 (5,340–8,600 particles/cc)	1.17 (1.11, 1.22)	1.03 (0.98, 1.08)
Quartile 3 (8,600–14,600 particles/cc)	1.27 (1.22, 1.33)	1.08 (1.02, 1.13)
Quartile 4 (>14,600 particles/cc)	1.32 (1.27, 1.39)	1.14 (1.08, 1.20)
NO_2		
Quartile 1 (<21.8 ppb)	—	Ref
Quartile 2 (21.8–23.8 ppb)	—	1.10 (1.05, 1.16)
Quartile 3 (23.9–25.5 ppb)	—	1.11 (1.05, 1.15)
Quartile 4 (>25.5 ppb)	—	1.15 (1.09, 1.22)
Exposed to noise >65 dB CNEL	—	1.10 (1.01, 1.19)

Association between Airport-Related Ultrafine Particles and Risk of Malignant Brain Cancer: A Multiethnic Cohort Study (Wu et al. Cancer Research 2021)

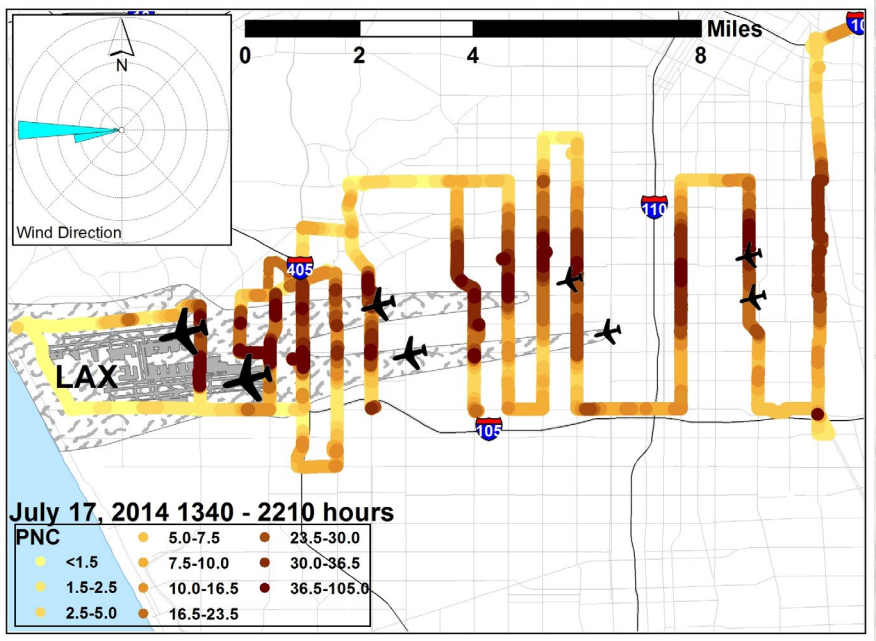
- Malignant brain cancer risk in all subjects combined increased 12% per interquartile range (IQR) of airport-related UFP exposure (~6,700 particles/cm3) for subjects with any address in the grid area surrounding the LAX airport.
- In race/ethnicity-stratified analyses, African Americans, the subgroup who had the highest exposure, showed a OR of 1.32 for malignant brain cancer per IQR in UFP exposure.

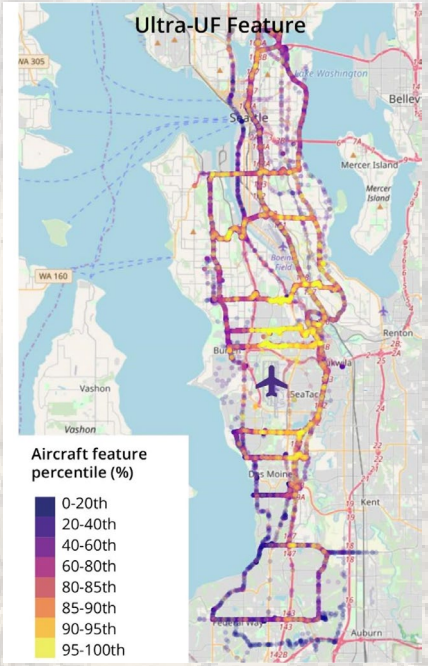


https://cancerres.aacrjournals.org/content/81/16/4360

Generalizable findings of air pollution and exposures near airports

1. The spatial extent of ground-level impacts of aviation/airport-related emissions is large (and challenging to characterize!). Also, underestimated and under-understood & misunderstood.

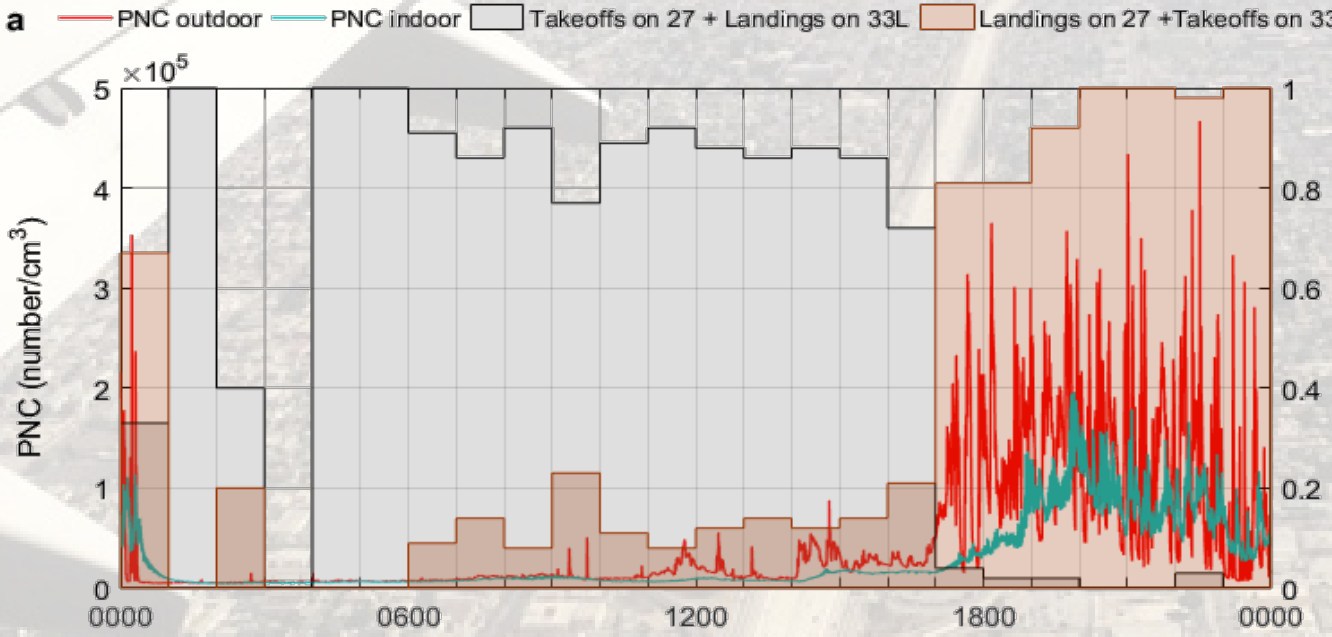




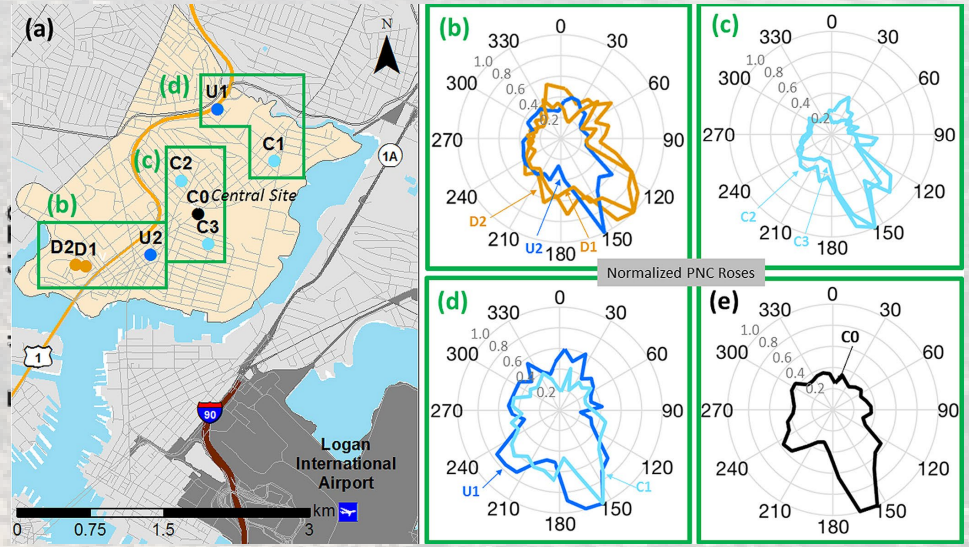
- Multiple studies have now recreated the 2014 LAX experiment (Hudda, Fruin et al.) and shown that impacts on UFP extend to long downwind distances.
  - Seattle, Boston, Mid-Atlantic region
  - Heathrow, Berlin, Schiphol, Toronto

Generalizable findings of air pollution and exposures near airports

2. The impacts on air quality are not limited to the outdoor environment; similar impacts have been observed indoors.



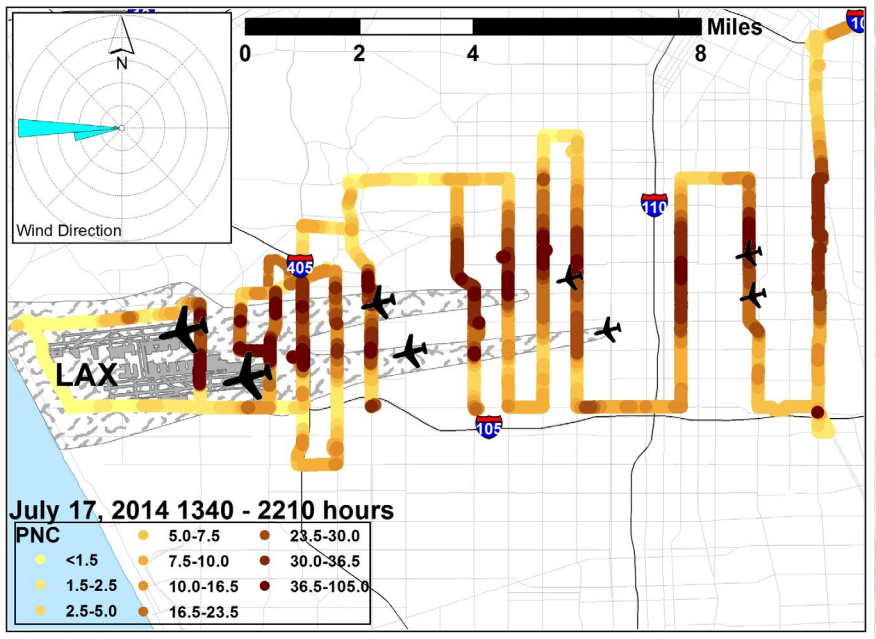
Hudda et al. 2020; EST

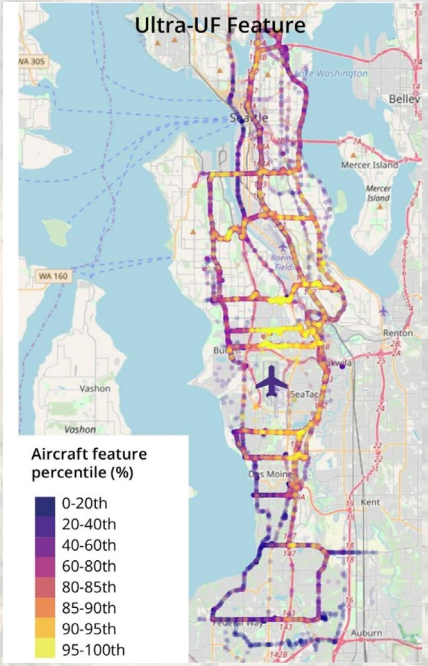


Hudda et al. 2018; EST

Generalizable findings of air pollution and exposures near airports

1. The spatial extent of ground-level impacts of aviation/airport-related impacts in large but….



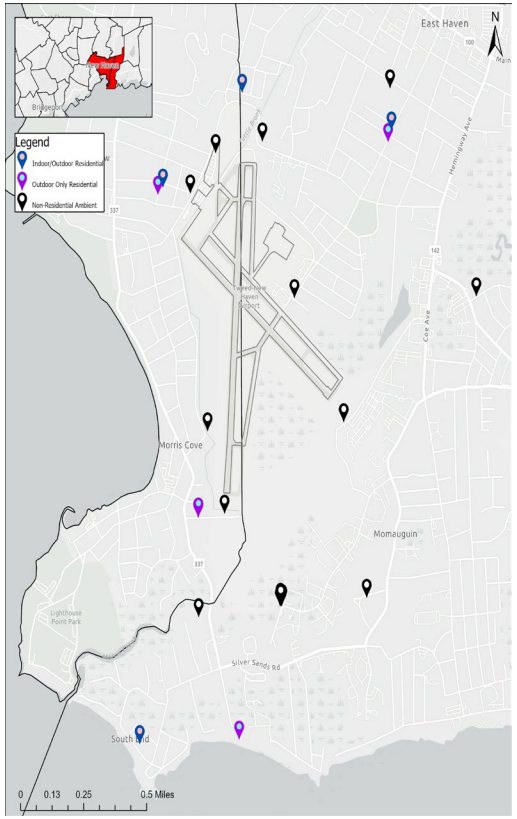


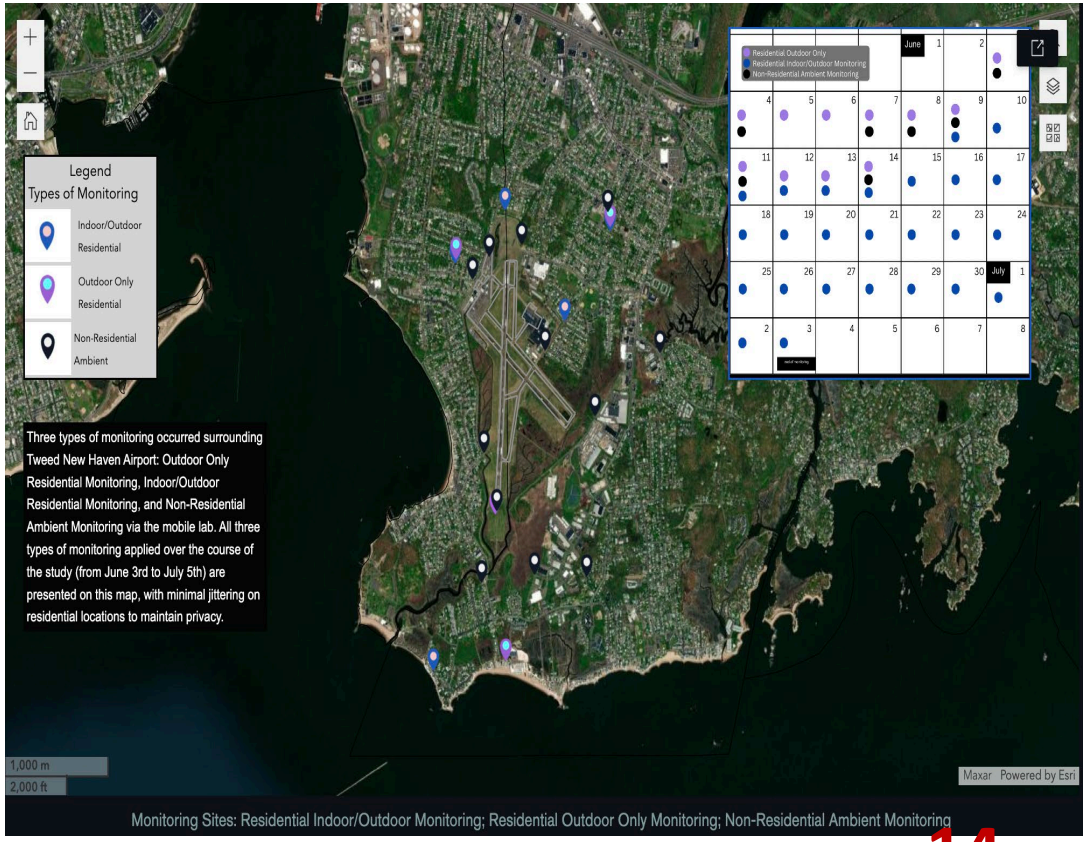
- ❑ Multiple studies have now recreated the 2014 LAX experiment (Hudda, Fruin et al.) and shown that impacts on UFP extend to long downwind distances.
- ❑ Most focused on large commercial airports and UFP.
  - General Aviation Airports
  - Other pollutants - NOX

Current issues in advancing understanding of air pollution and exposures near airports

General Aviation Airports are a distinct situation

- Runway Protection Zone is absent and people live in proximity of the airport.
- Community and town resources are limited to understand the impacts





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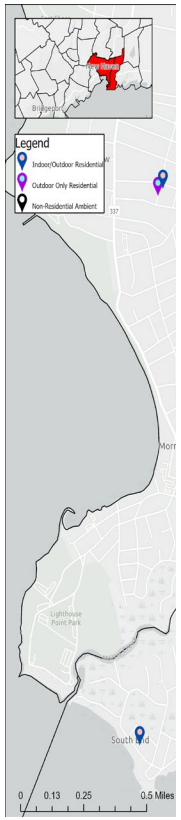

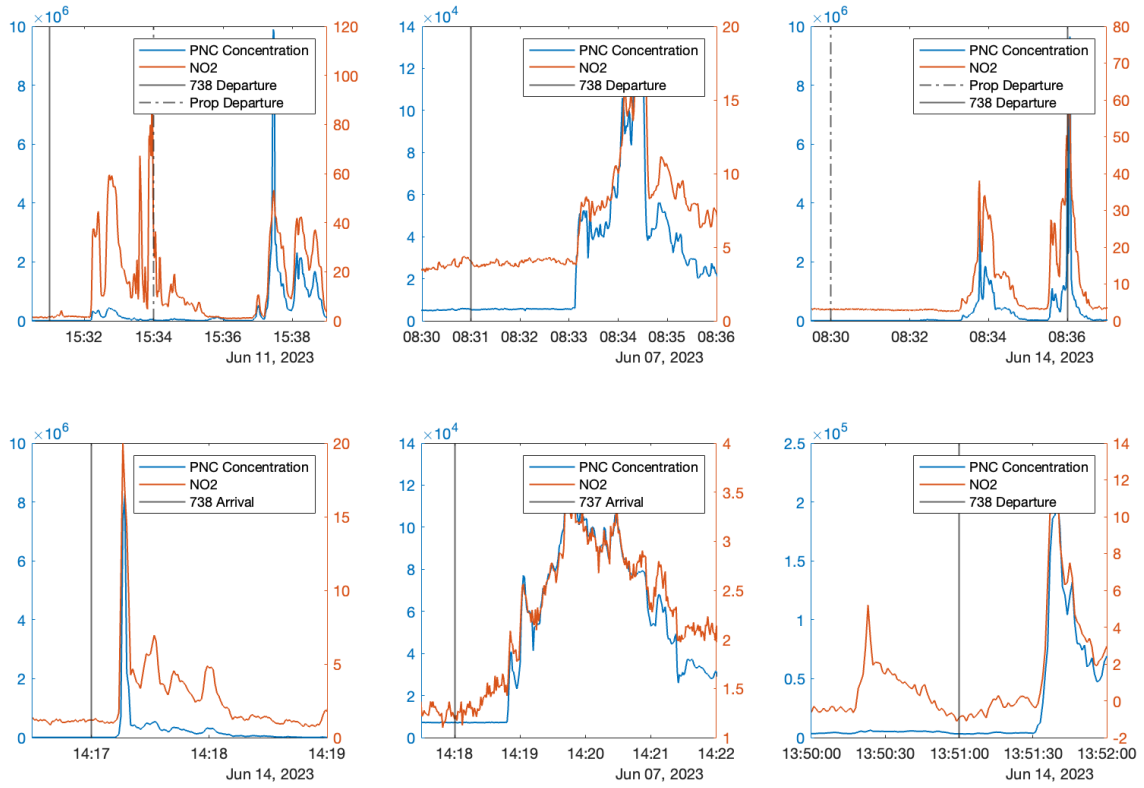

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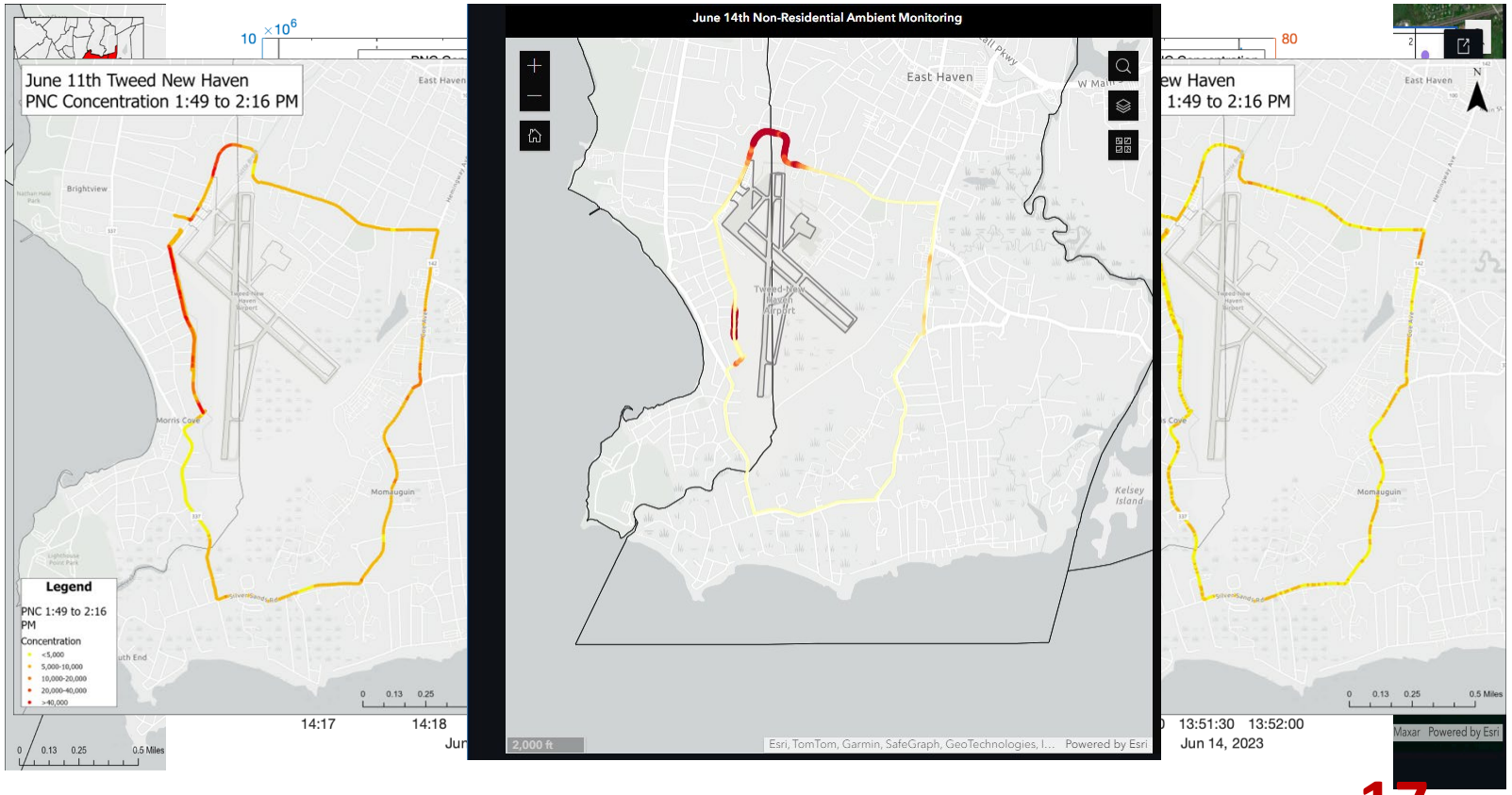
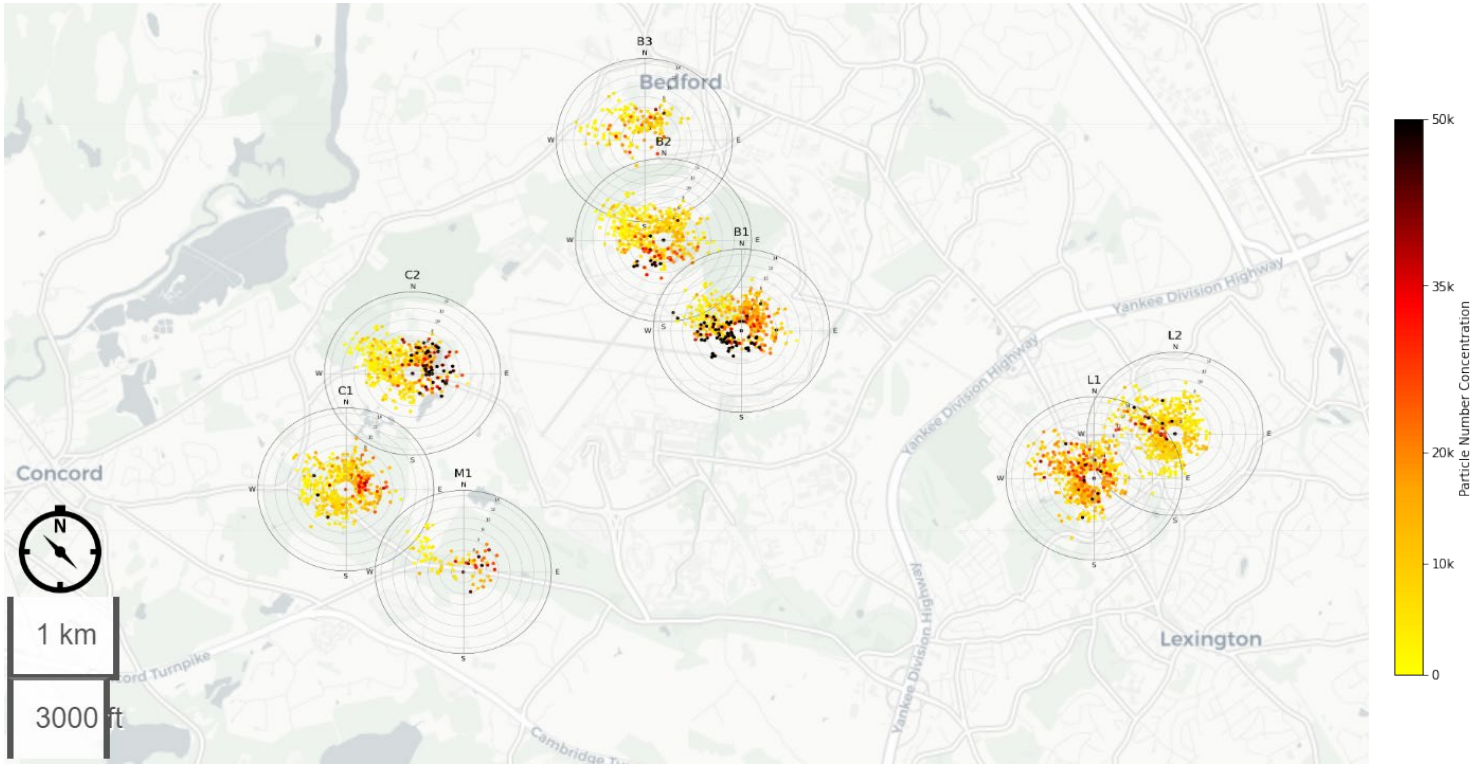


Current issues in advancing understanding of air pollution and exposures near airports

General Aviation Airports are a distinct situation

- Expansions are common to accommodate commercial and private jets
  - Hanscom – private jet
- Sometimes, they wipe out all possible greenhouse gains communities are making



https://drive.google.com/file/d/10GDtx7tZgpk-H4PM0_5jAM1APfnRKE_c/view
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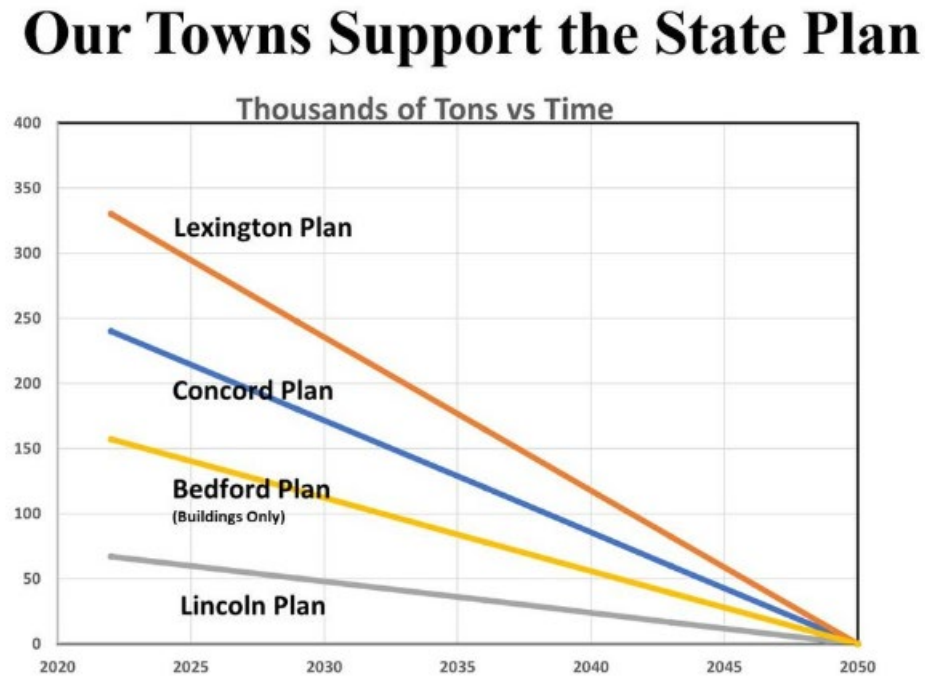

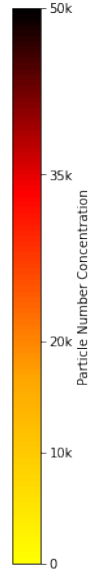

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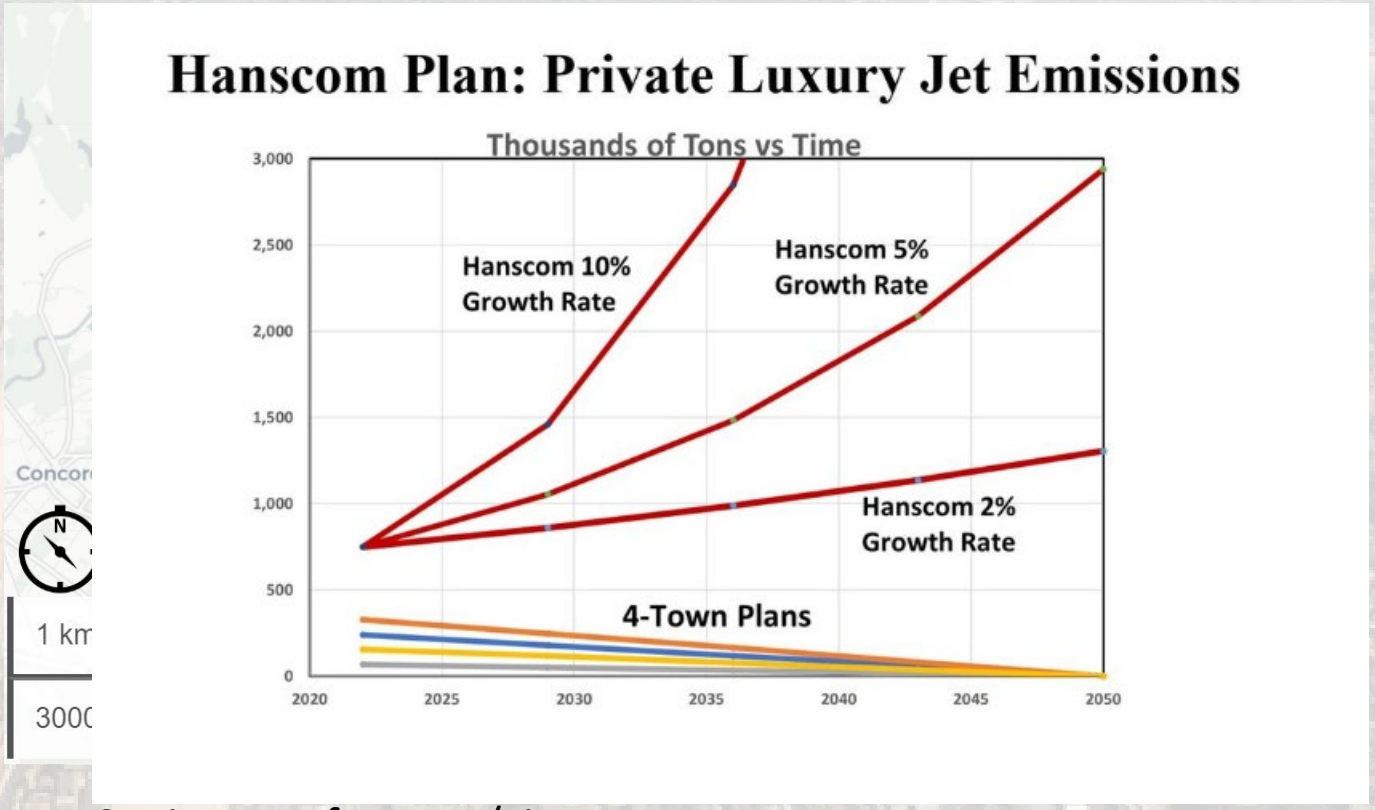

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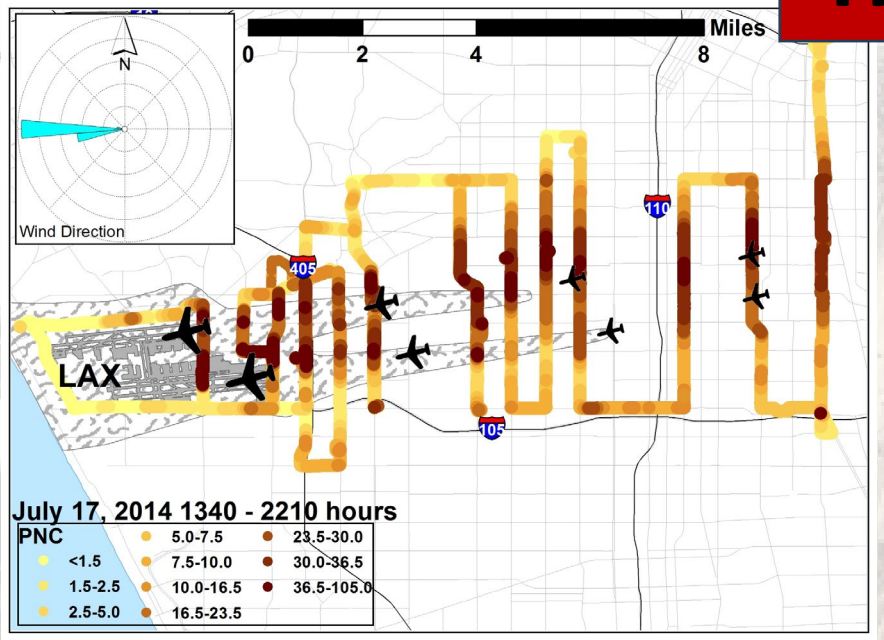
Current issues in advancing understanding of air pollution and exposures near airports

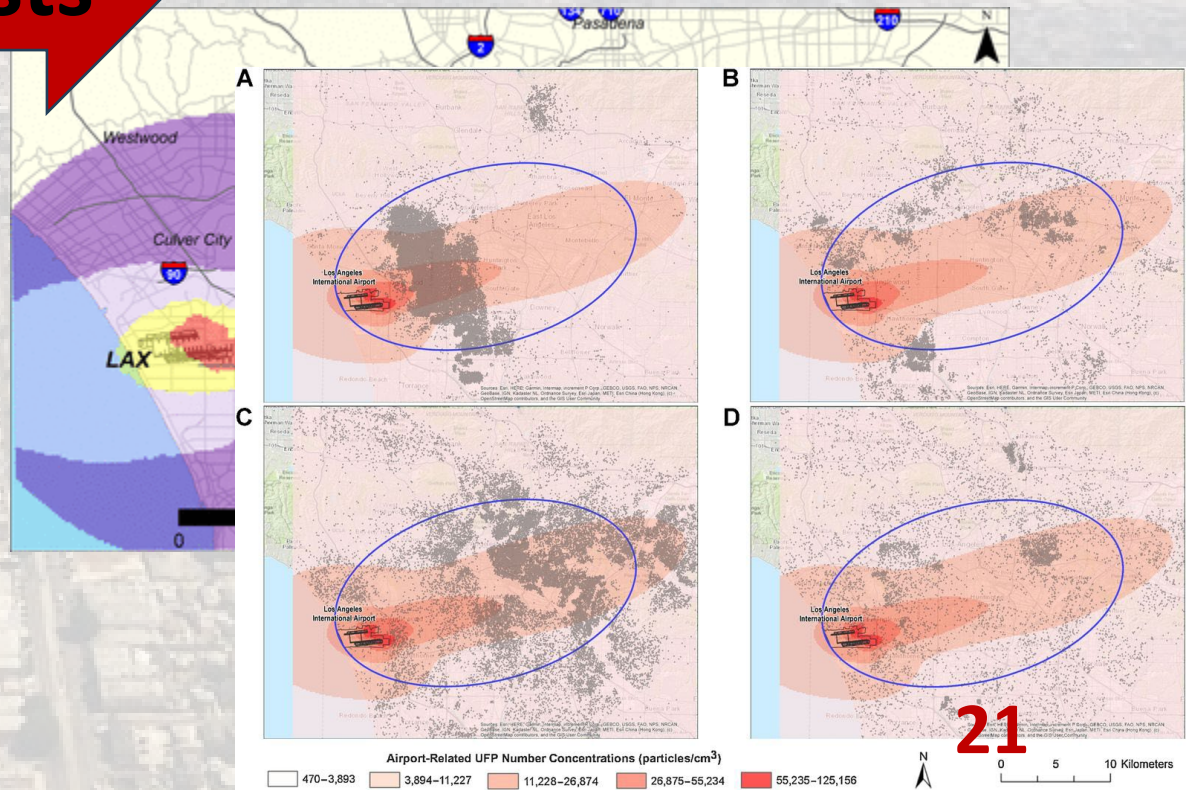
Scalability of findings and development exposure models

2012



Time, Costs

2020, 2021



Current issues in advancing understanding of air pollution and exposures near airports

Translating findings to actionable data and policy

1. Ultrafine particles aren't regulated!
2. FONSI: Findings Of No Significant Impact when it comes to regulated pollutants

Enough information for action on ultrafine particles.
Evidence for starting at receptor side controls (similar to sound proofing)

- Perhaps, even start with exploration of co-benefits
- Collaborative partnerships with communities

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