

# Ultrafine Particles Near Airports

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# Acknowledgements

## UW

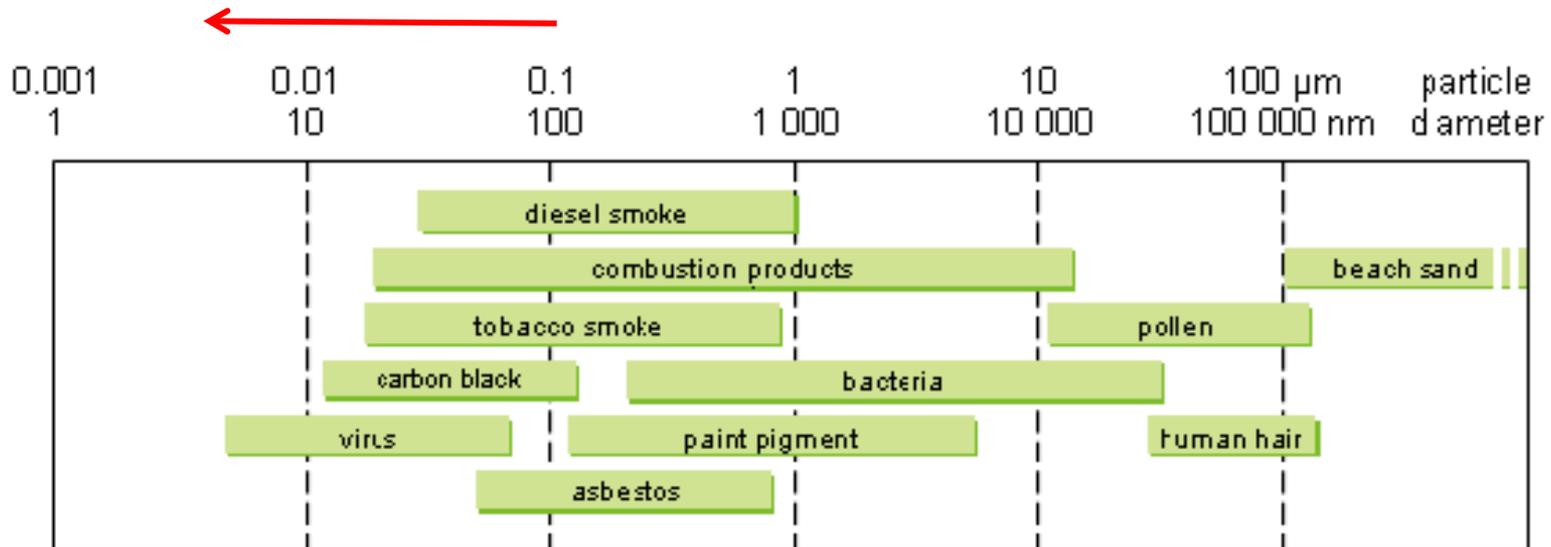
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Jecca Canet

## USC

Scott Fruin  
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# What are Ultrafine Particles?

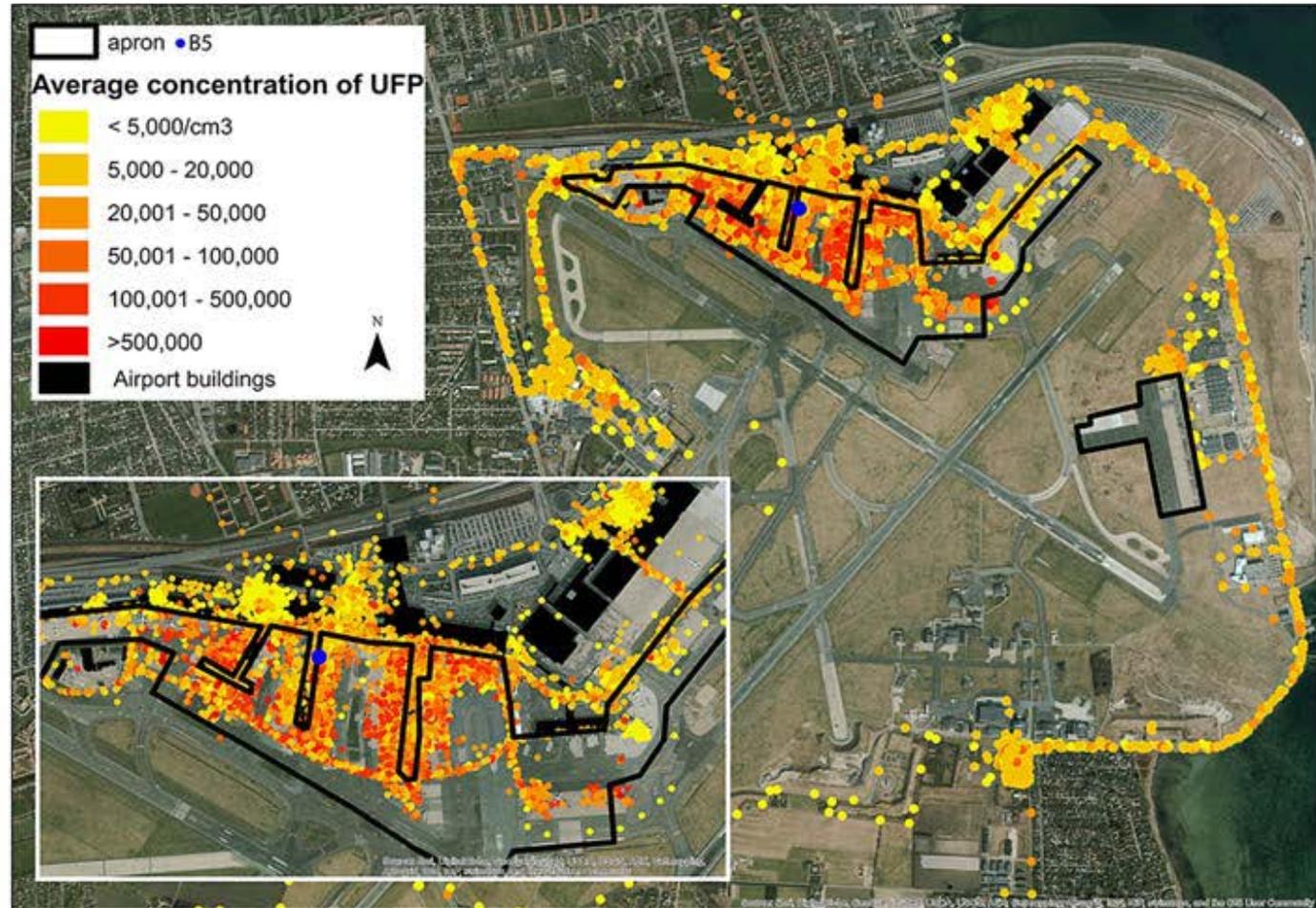
## Ultrafine Particles (UFPs)



ACI EUROPE UFP Study 2012

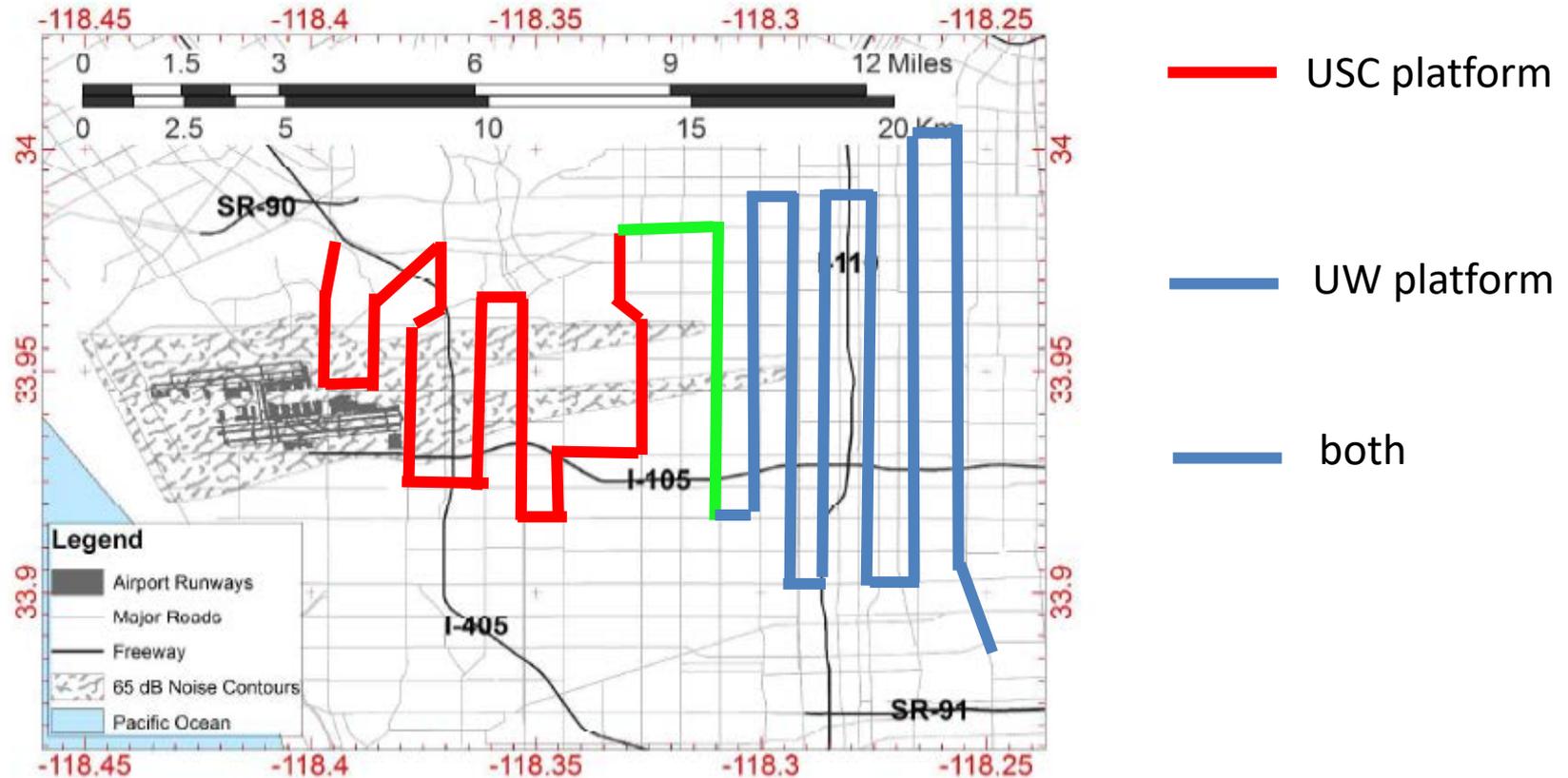
(<https://www.cph.dk/contentassets/04a9b35237a547d1a924ea3c9df25c31/aci-europe-study-on-ultrafine-particles-at-airports.pdf>)

# Occupational exposures to UFP are known to be high in some settings.



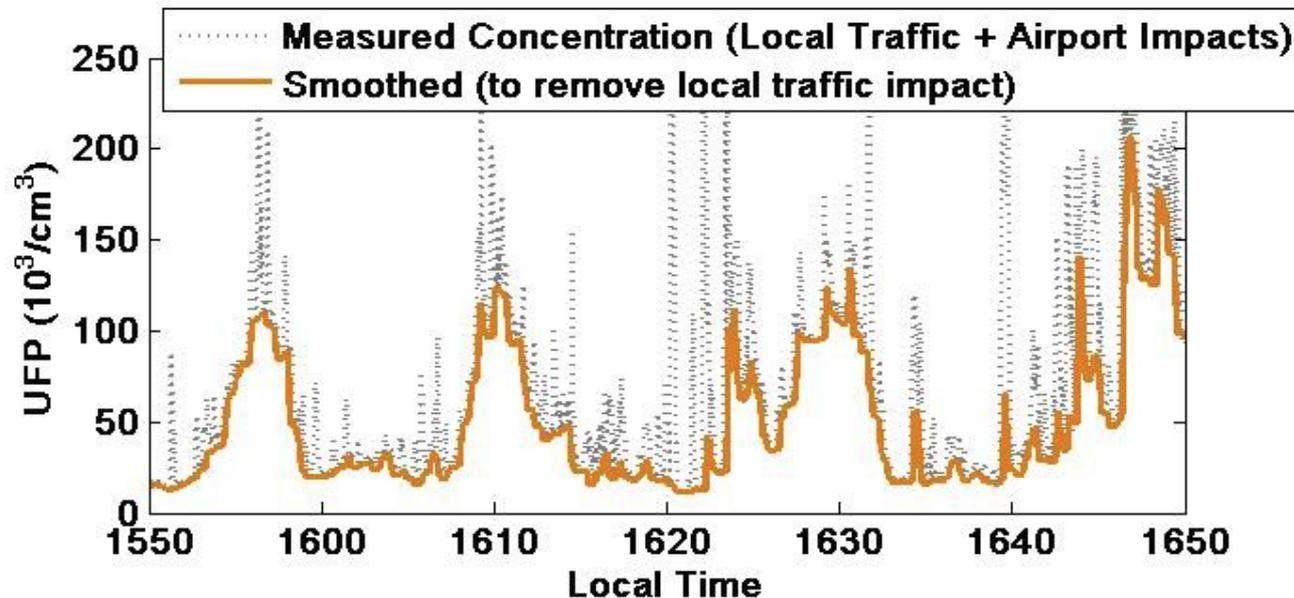
A map of personal exposure concentrations for workers at the Copenhagen airport in Autumn of 2012 is shown at right.

# Sampling Routes near LAX



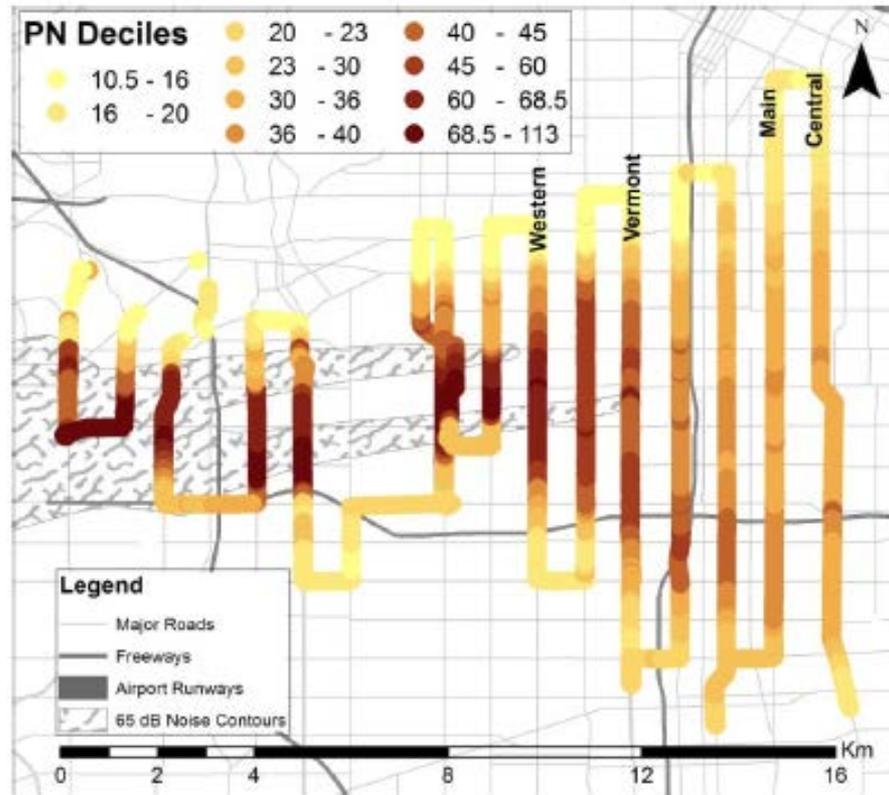
# Examining Local Background Values Reveals the Aircraft Impacts

- Apply rolling 5<sup>th</sup> percentile of 1 second data using a 30 second window
- This removes local scale impacts

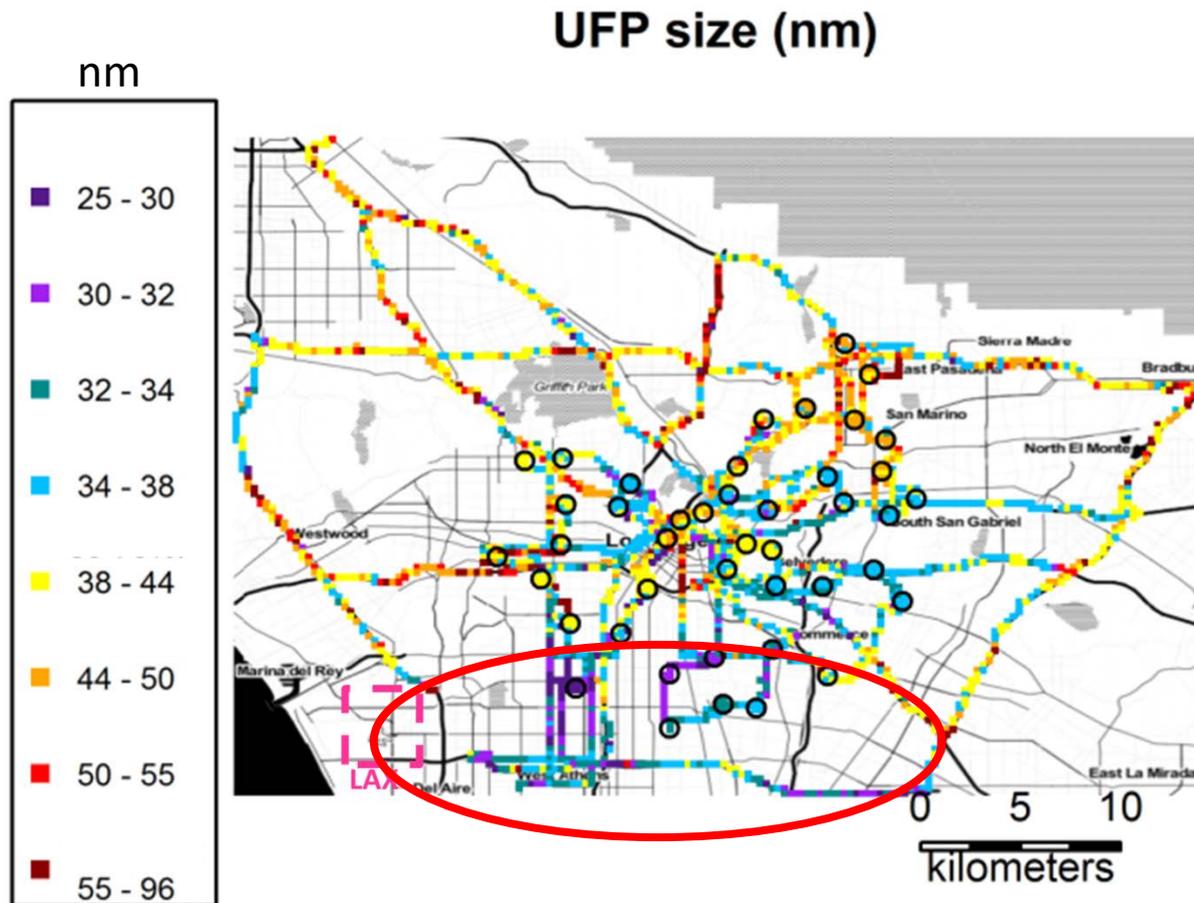


Area-weighted number concentration equivalent to  $\sim$  half the freeways in LA!

$10^3/\text{cc}$

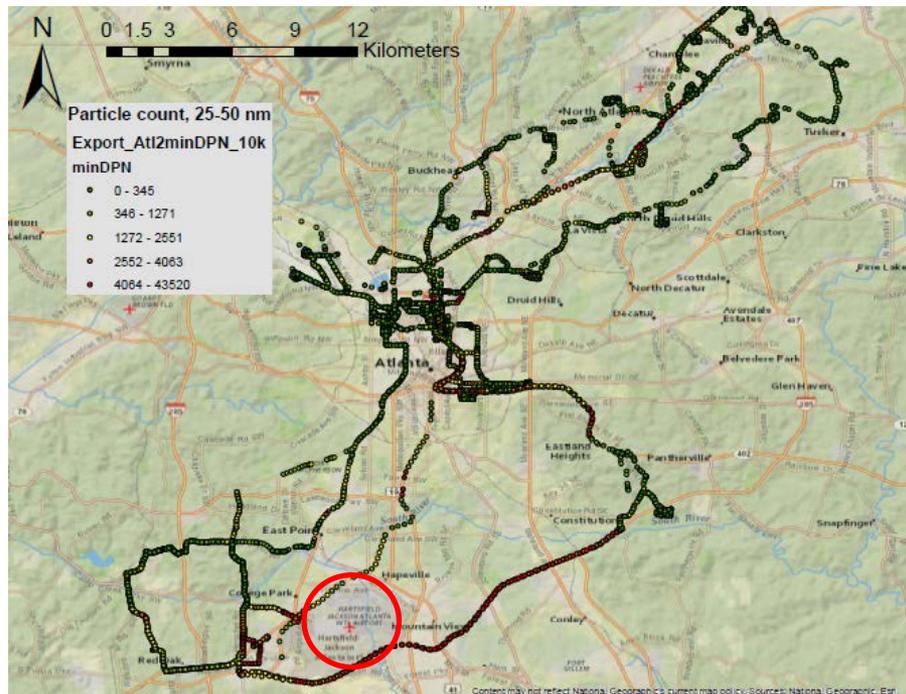


Particles between ~25 and 30 nm diameter reveal an extended plume downwind of LAX

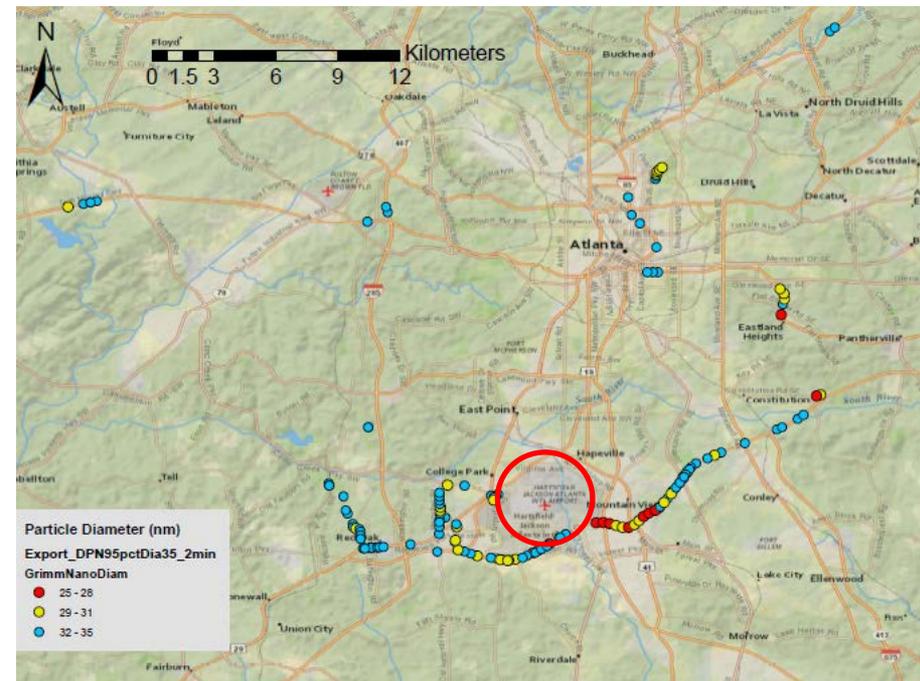


# Airport-associated UFP Impacts Revealed Using a Combination of particle size and concentration

All mobile monitoring locations



$\Delta PN > \text{daily } 95^{\text{th}}\%$ ; Particle size  $< 35 \text{ nm}$



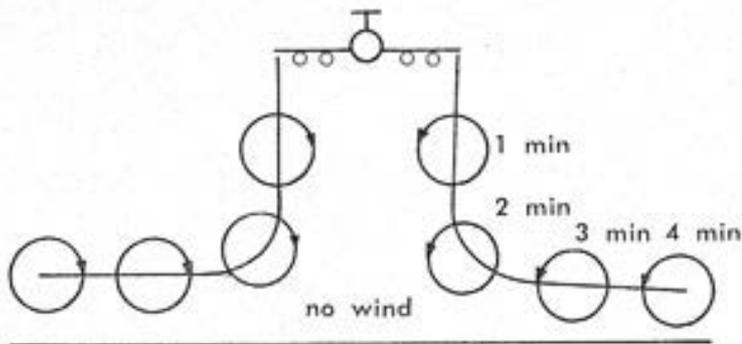
Elevated UFP concentrations observed at fixed locations 8 and 14 km downwind of Schiphol airport in Amsterdam.



Particles with diameters between 10 and 20 nm show higher number concentrations when the wind is coming from the airport



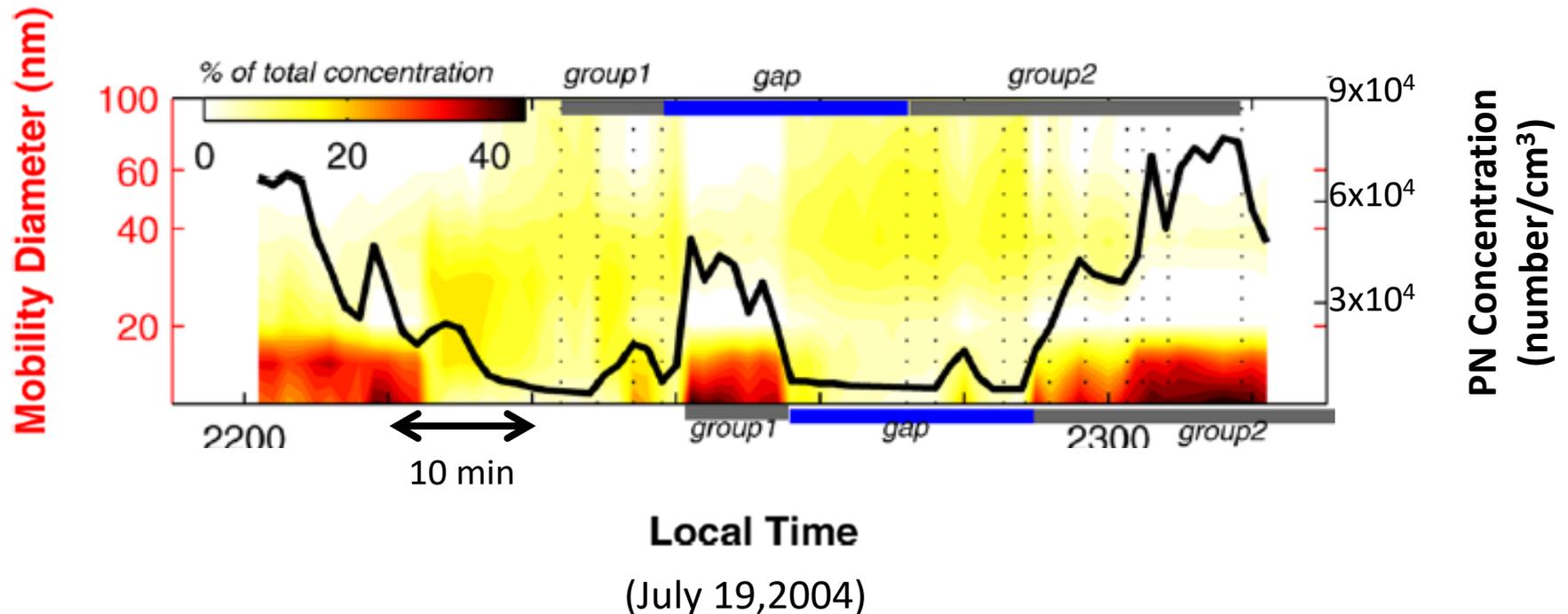
<https://www.flickr.com/photos/44073224@N04/>



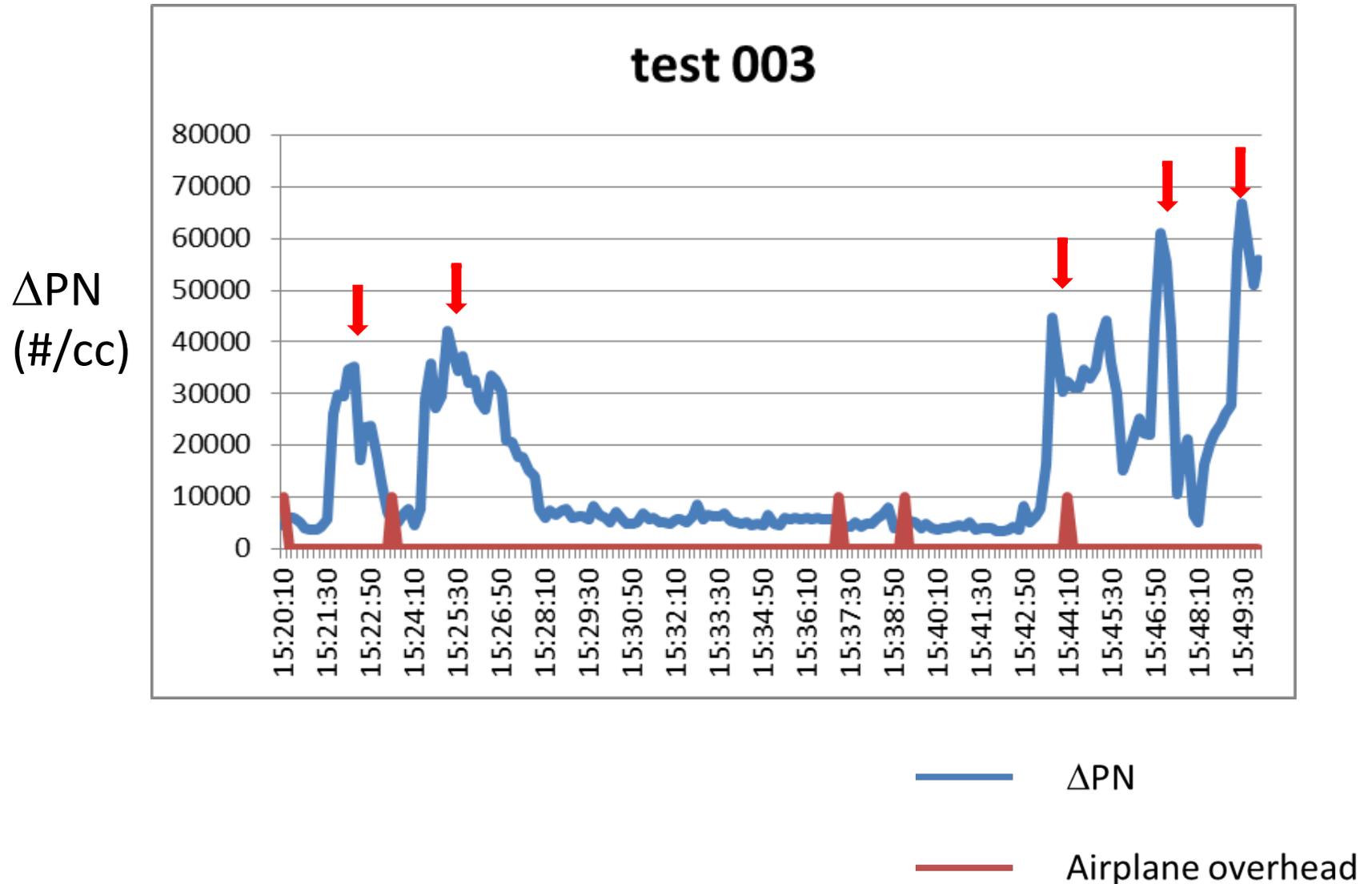
“Vortices generated below about 1500 feet usually sink to just above the ground, 50 to 100 feet. Their speed of descent varies with the type of aircraft and with the local atmospheric conditions. A figure of 450 feet per minute is typical of large sweptwing jet transports. As the vortices approach the ground, they spread apart and move sideways, at right angles to the runway, at the same 450 feet per minute, roughly 5 miles per hour.”

--**Andrew S. Carten, Jr.** (M.S., Tufts University) is Chief, Equipment Engineering and Evaluation Branch, Aerospace Instrumentation Laboratory, Air Force Cambridge Research Laboratories. Available: <http://www.airpower.maxwell.af.mil/airchronicles/aureview/1971/jul-Aug/carten.html>

Particles between ~10 and 20 nm diameter are present in high concentrations at ground level ~3 km downwind of northern runway at LAX



# Elevated UFP levels observed ~1 km North of Sea-Tac Runway



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

R. Habre<sup>1</sup>, S. P. Eckel<sup>1</sup>, S. Fruin<sup>1</sup>, T. Enebish<sup>1</sup>, E. Rappaport<sup>1</sup>, F. Gilliland<sup>1</sup>

<sup>1</sup>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”**

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Online Abstracts Issue

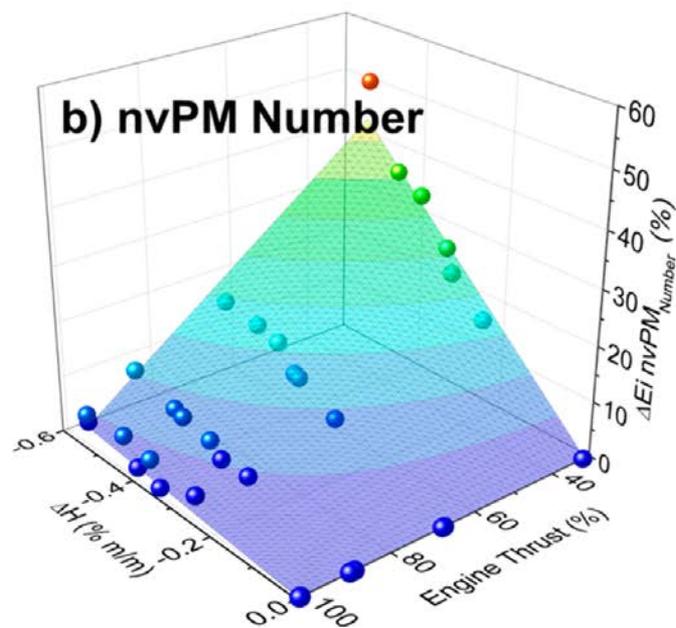
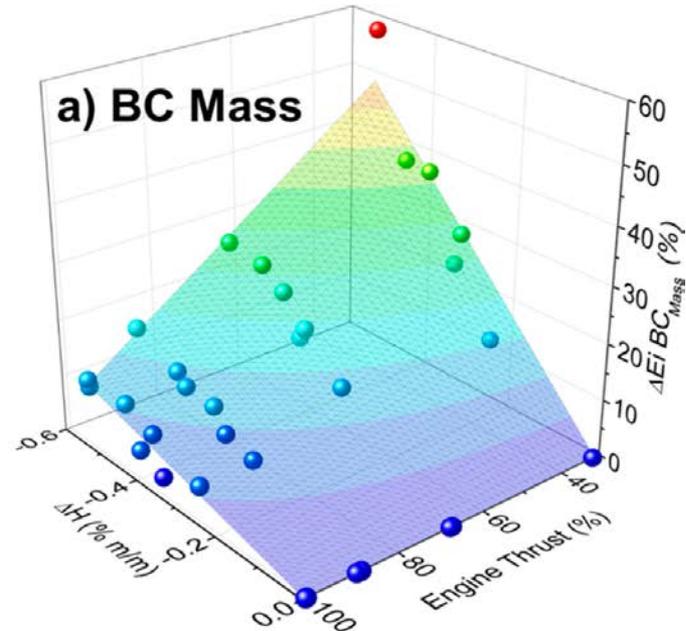
Aircraft Turbine Emissions are lower at lower engine thrust and at higher fuel hydrogen content.

Effects of Fuel Aromatic Content on Nonvolatile Particulate Emissions of an In-Production Aircraft Gas Turbine

Benjamin T. Brem,<sup>†,‡</sup> Lukas Durdina,<sup>†,‡</sup> Frithjof Siegerist,<sup>§</sup> Peter Beyerle,<sup>§</sup> Kevin Bruderer,<sup>§</sup> Theo Rindlisbacher,<sup>||</sup> Sara Rocci-Denis,<sup>⊥</sup> M. Gurhan Andac,<sup>#</sup> Joseph Zelina,<sup>#</sup> Olivier Penanhoat,<sup>▽</sup> and Jing Wang<sup>\*,†,‡</sup>

DOI: 10.1021/acs.est.5b04167

Environ. Sci. Technol. 2015, 49, 13149–13157



# Summary

Relatively high concentrations of Ultrafine particles less than ~35 nanometers in diameter have been observed with 5km downwind of busy airports

A few studies have detected downwind ufp impacts up to 20 km downwind

The relative contribution of landings and take-offs versus on-site emissions to these extended downwind plumes has not been clearly established, although there is suggestive evidence that aircraft vortices may play an important role

Health effects studies of airport-associated ultrafine particles is very limited, with only one preliminary study found to date



# Recent Studies Suggesting Acute Health Effects in Susceptible Populations

TOXICOLOGICAL SCIENCES **140**(1), 61–72 2014  
doi: 10.1093/toxsci/kfu063  
Advance Access publication April 9, 2014

## Controlled Exposure of Humans with Metabolic Syndrome to Concentrated Ultrafine Ambient Particulate Matter Causes Cardiovascular Effects

Robert B. Devlin,<sup>\*1</sup> Candice B. Smith,<sup>\*2</sup> Michael T. Schmitt,<sup>\*</sup> Ana G. Rappold,<sup>\*</sup> Alan Hinderliter,<sup>†</sup> Don Graff,<sup>\*3</sup> and Martha Sue Carraway<sup>\*</sup>

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DOI 10.1186/s12989-015-0083-7



RESEARCH

Open Access

Elevated particle number concentrations induce immediate changes in heart rate variability: a panel study in individuals with impaired glucose metabolism or diabetes

Annette Peters<sup>1,2\*</sup>, Regina Hampel<sup>1</sup>, Josef Cyrys<sup>1,3</sup>, Susanne Breitner<sup>1</sup>, Uta Geruschkat<sup>1</sup>, Ute Kraus<sup>1</sup>, Wojciech Zareba<sup>4</sup> and Alexandra Schneider<sup>1</sup>

Controlled Exposures to Concentrated Ambient Particles

Exposures Documented with Personal Monitors