

IMPACT OF AIRCRAFT EMISSIONS ON LOCAL AIR QUALITY: *FINDINGS FROM LOS ANGELES AND BOSTON*



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Jan 22, 2020

AVIATION EMISSIONS IMPACT AIR QUALITY AT GLOBAL TO LOCAL SPATIAL SCALES

Globally,

- Climate change impacts
- Emissions contribute to global burden of disease

Nationally,

- Inventory of Lead and other pollutants

Regionally,

37/50 primary US airports are in counties considered nonattainment areas for 8-hr ozone standard (Boston: Moderate attainment), Emit NO_x (> Ozone chemistry)

AVIATION EMISSIONS IMPACTS AT **LOCAL** SPATIAL SCALES

Locally,

- Environmental pollutants like noise
- Locally concentrated, high concentration of air pollution
- Concentrated exposures and health effects
- Quality of life
- Socio-economic stressors, like, property values

Noise and Health

Vast amount of literature exists on the matter

- Exposure to noise has adverse health effects
- Exposure to **elevated levels on noise from aircrafts** has also been associated with:
 - Increased rates near airports of
 - hypertension
 - rates of hypertensive medication prescription
 - cardiovascular disease incidence
 - cardiovascular disease related hospitalization
 - adverse learning outcomes in children

Noise and Health

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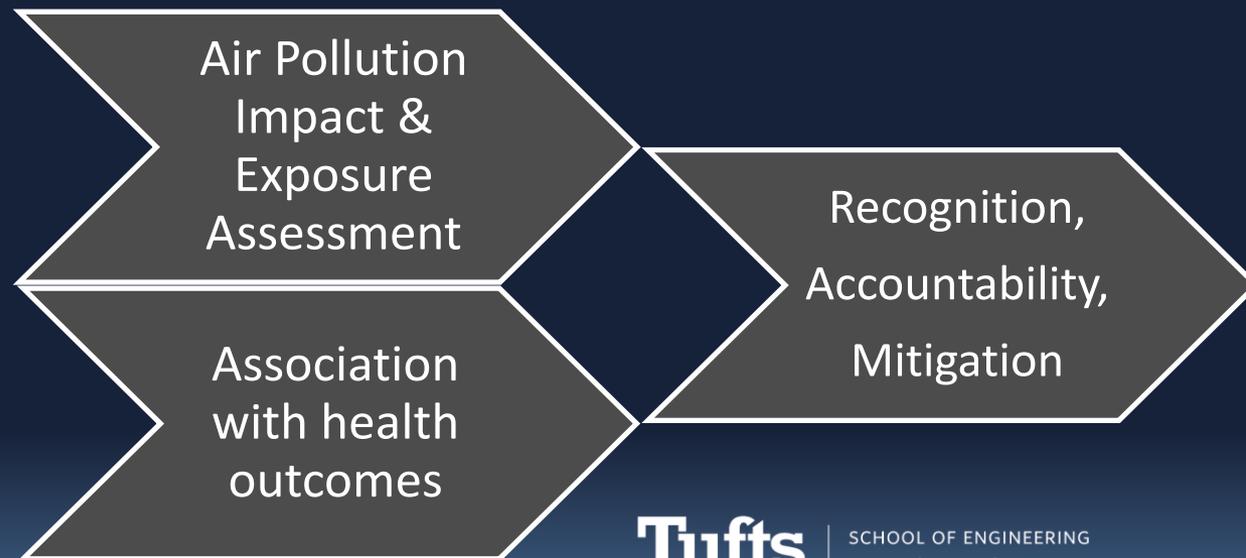
FAA recognizes the adverse noise impacts and provides mitigation measures in 65 dNL zone

- adverse learning outcomes in children

Air Pollution and Health

EVEN MORE!!! Vast amount of literature exists on the matter

- Exposure to air pollution has adverse health effects
- Exposure to **elevated levels on air pollution from aircrafts/near-airports** has been understudied/essentially unstudied



What is the spatial extent of local air quality impacts ?

Increasingly, in context of aviation emissions, local \equiv 10 kilometer

Our work shows that the impacts extend much farther than spatial scales that had been studied previously (~3.5 km pre-2014).

- ❑ In Los Angeles we detected impacts up to 20 km
- ❑ In Boston we detected impacts up to 7.5 km

Not all airports are the same.

Definition of IMPACT

An **INCREASE OR ELEVATION IN CONCENTRATION** compared to:

The background

concentration outside the zone of impact (spatial differences)

concentration in the absence of the impact (temporal differences)

The conditions not associated with the impact

Wind directions that don't favor impact

PRESENCE versus ABSENCE of source

Definition of AIR POLLUTION

It is a very wide term. It covers a wide range of pollutants.

- ❑ gases and particulate pollutants
- ❑ jet engine-exhaust and non-exhaust emissions + GSE
- ❑ regulated and unregulated pollutants

Exposure occurs to a complex mixture of pollutants that evolves with time and distance from the airport and interacts with microenvironments of exposure

AIR POLLUTANTS in FOCUS TODAY

Ultrafine particles; excellent tracer of jet-exhaust emissions

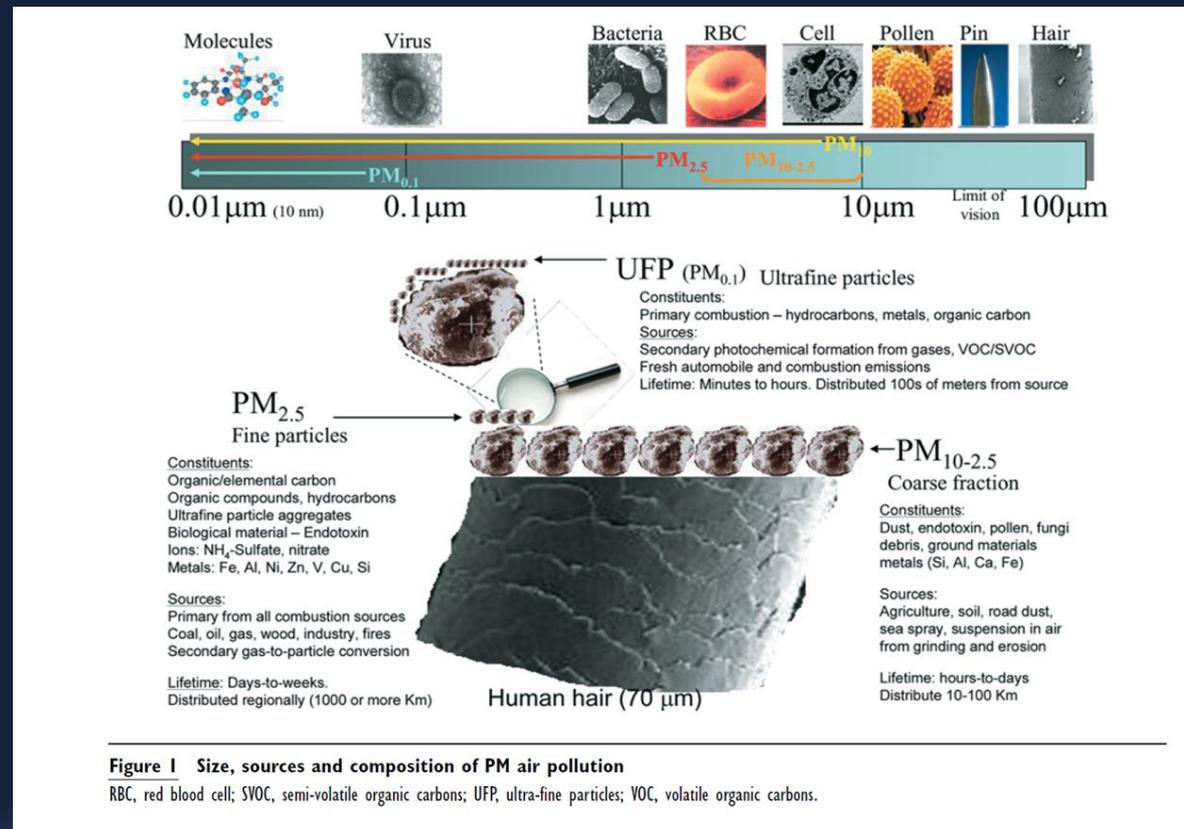
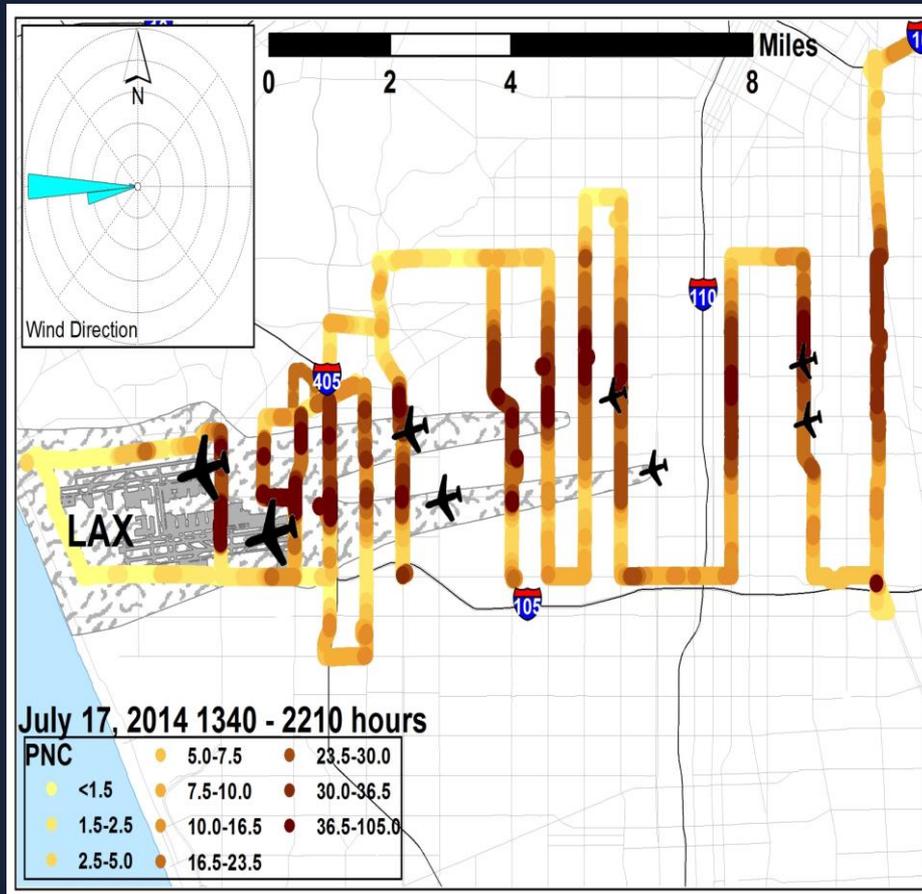


Figure 1 Size, sources and composition of PM air pollution

RBC, red blood cell; SVOC, semi-volatile organic carbons; UFP, ultra-fine particles; VOC, volatile organic carbons.

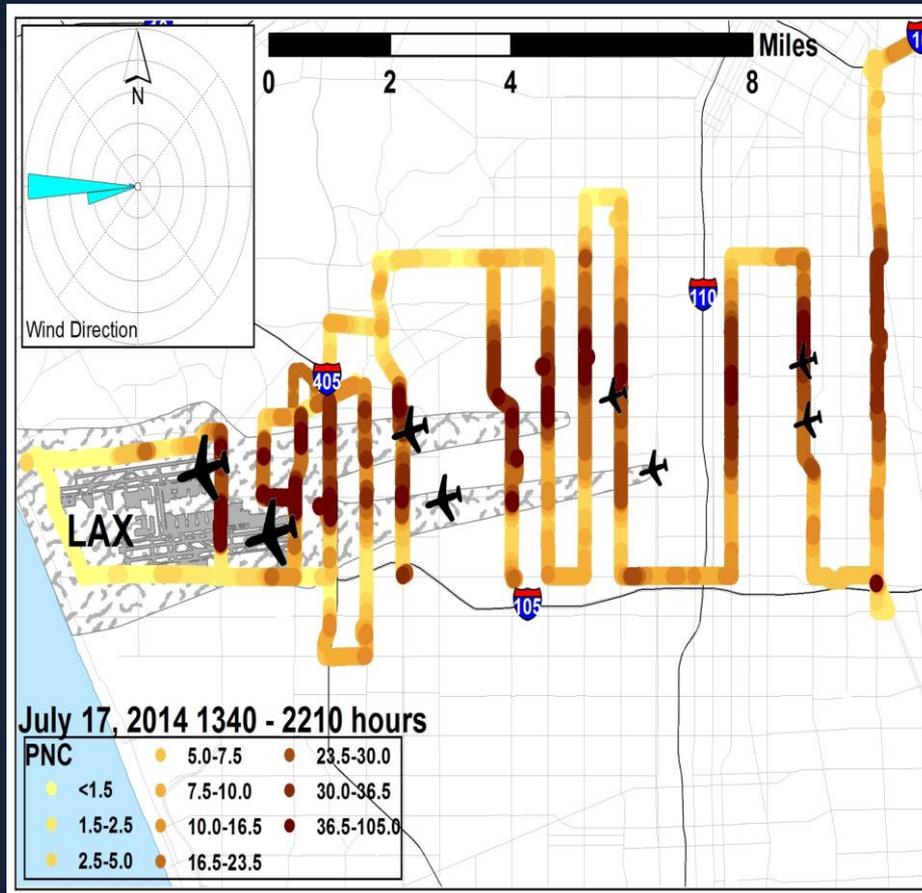
Key Findings from Los Angeles



A very large spatial zone of impact

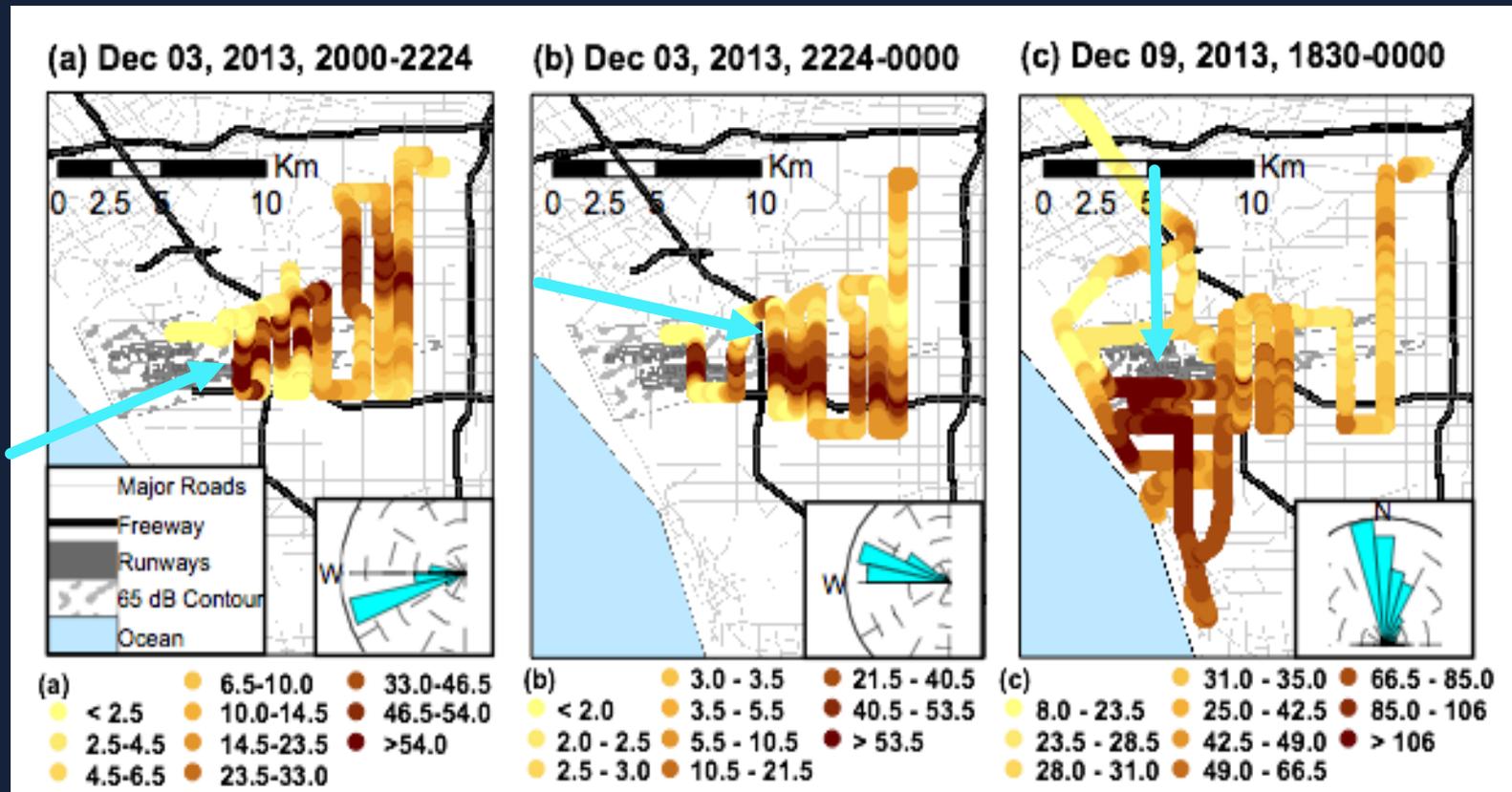
- ❑ 100-900% increase in PNC extended 20 km downwind
- ❑ Concentrations increased by about 35,000 particles/cm³ over a 30-65 km² area

Key Findings from Los Angeles



- ❑ Impact concentrated downwind of the airport
- ❑ But impact zone shifts with wind direction

Key Findings from Los Angeles

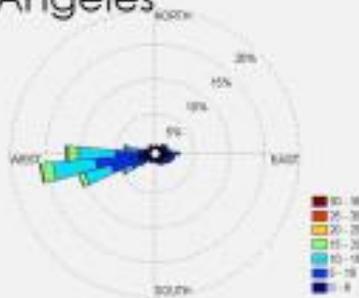


Wind direction determines where the impact is concentrated

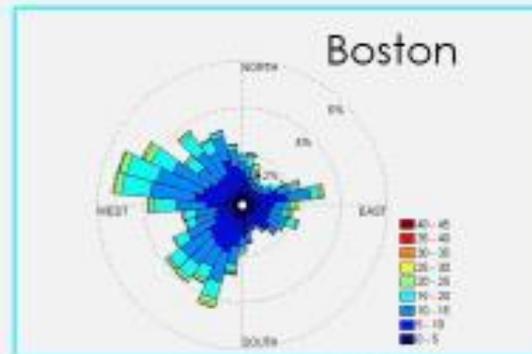
Key Findings from Los Angeles

LOS ANGELES STUDY: ATYPICAL WIND CONSISTENCY

Los Angeles



Boston



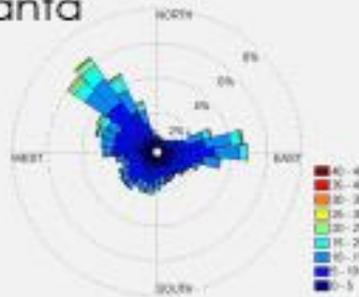
Boston presents particular challenges

Shifting winds

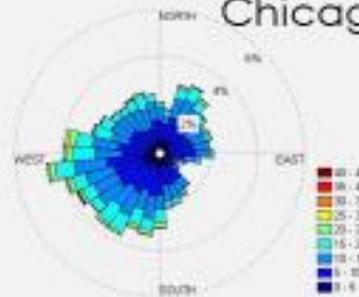
Multiple runway configurations

Resulting impacts may be intermittent and dispersed over many downwind sectors.

Atlanta



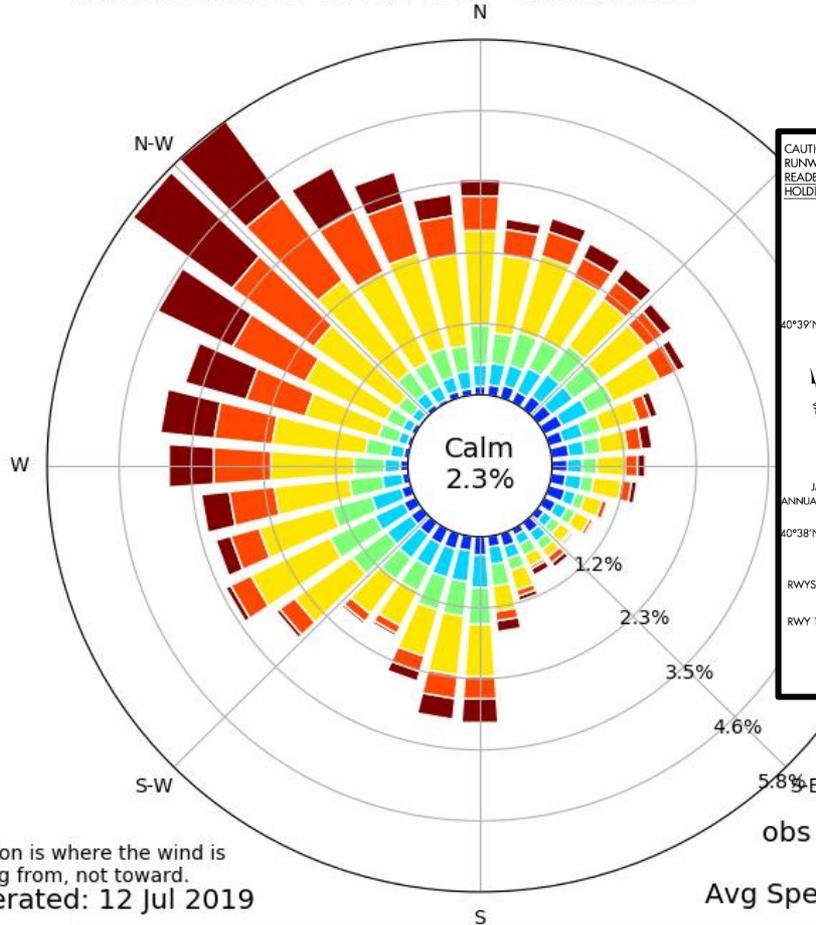
Chicago



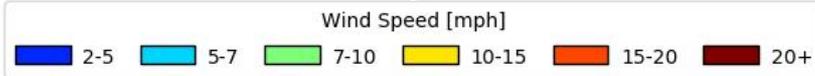
JFK: Windrose and Runway



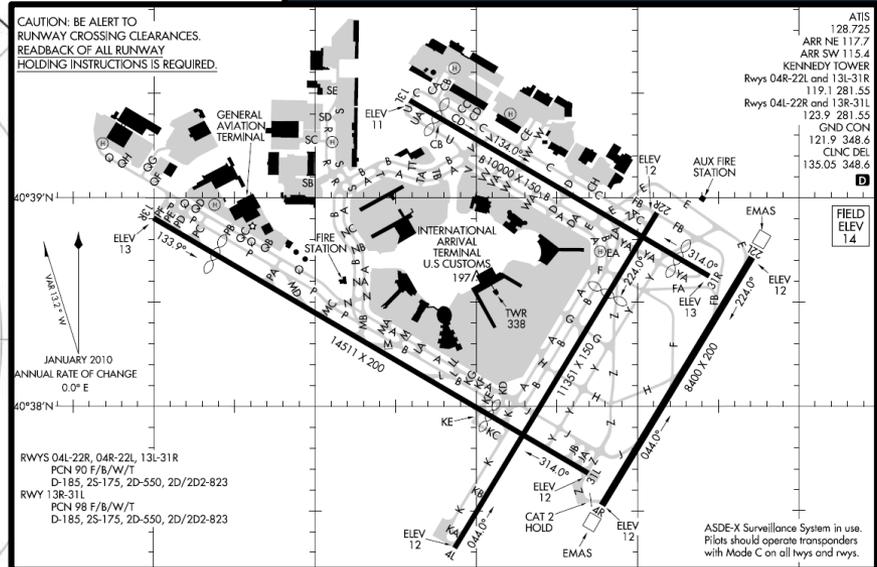
[JFK] NEW YORK/JF KENNEDY
 Windrose Plot [Time Domain: Feb,]
 Period of Record: 01 Feb 1970 - 28 Feb 2019



Direction is where the wind is blowing from, not toward.
 Generated: 12 Jul 2019



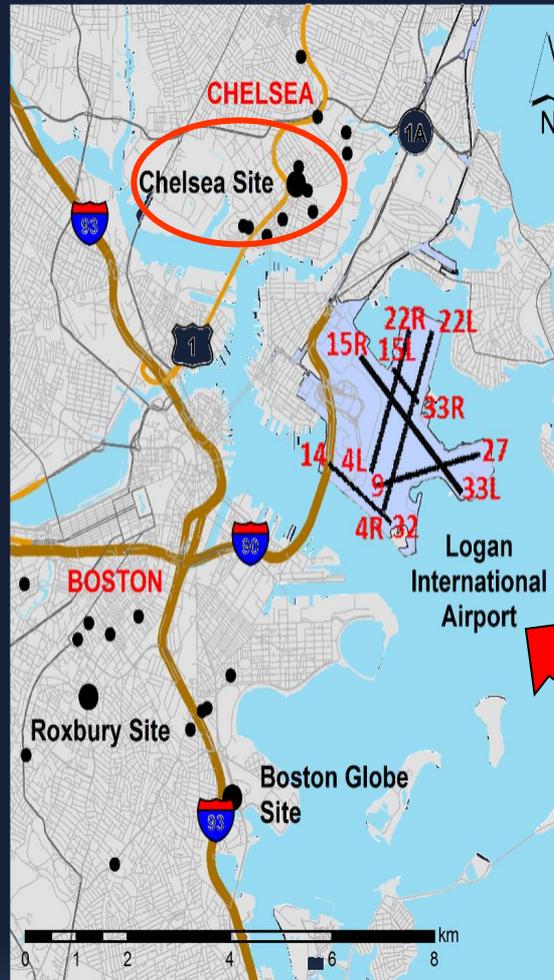
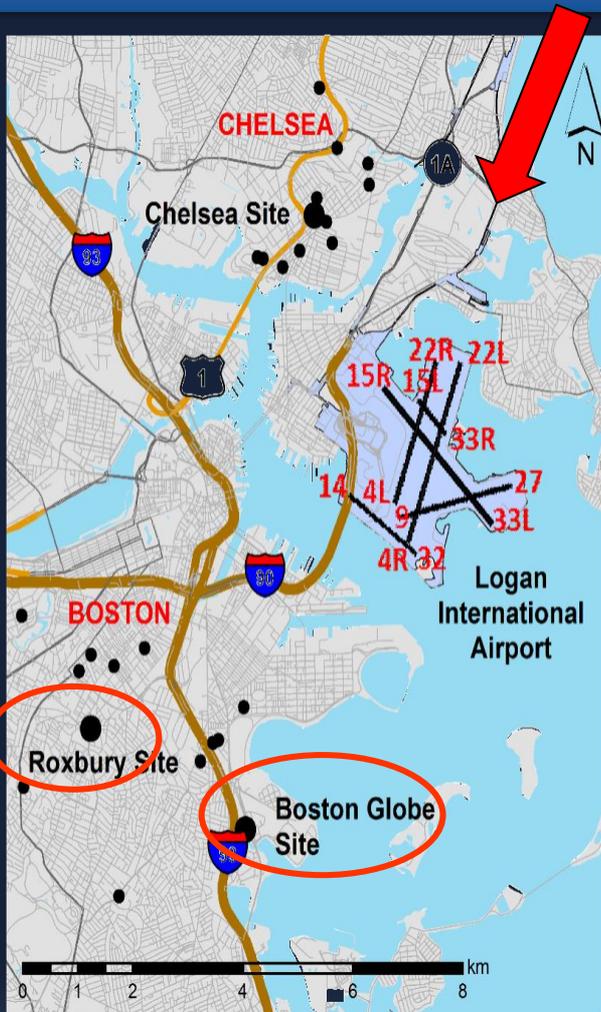
Summary
 obs count: 36167
 Missing: 103
 Avg Speed: 12.9 mph



SCHOOL OF ENGINEERING

Civil and Environmental Engineering

Key Findings from Boston

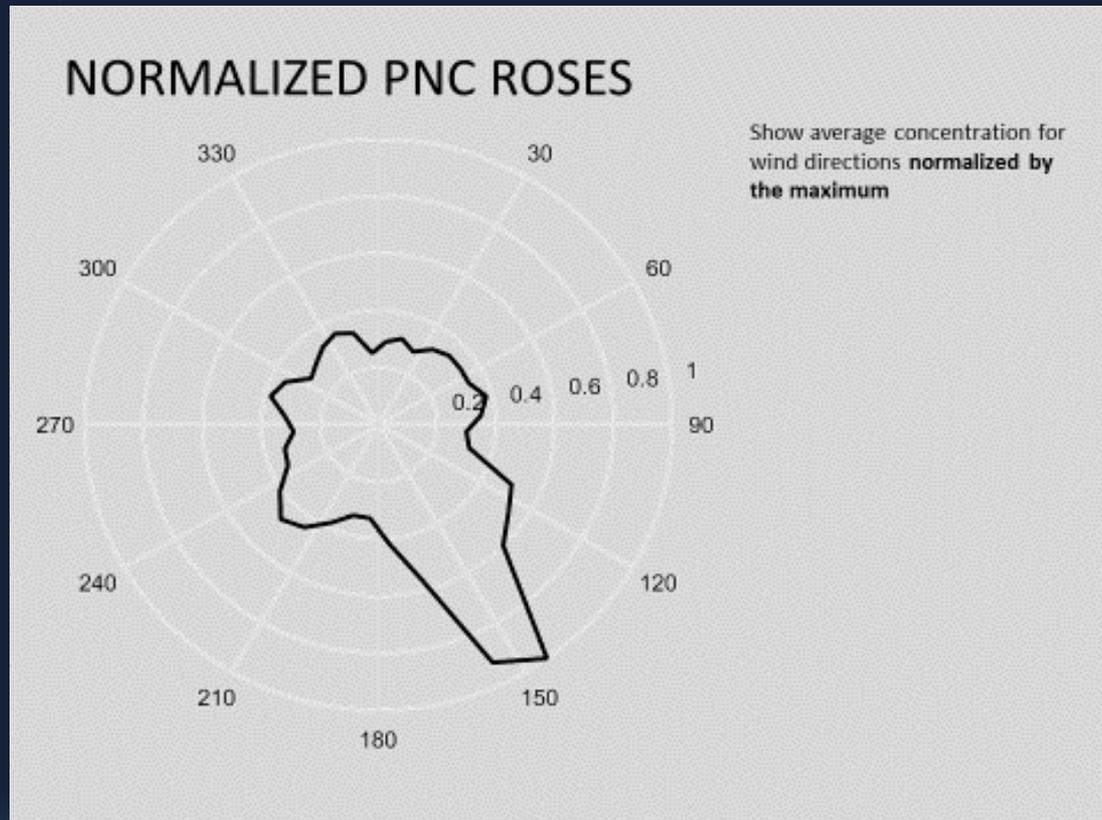


Short-term: We studied 16 homes in two different communities

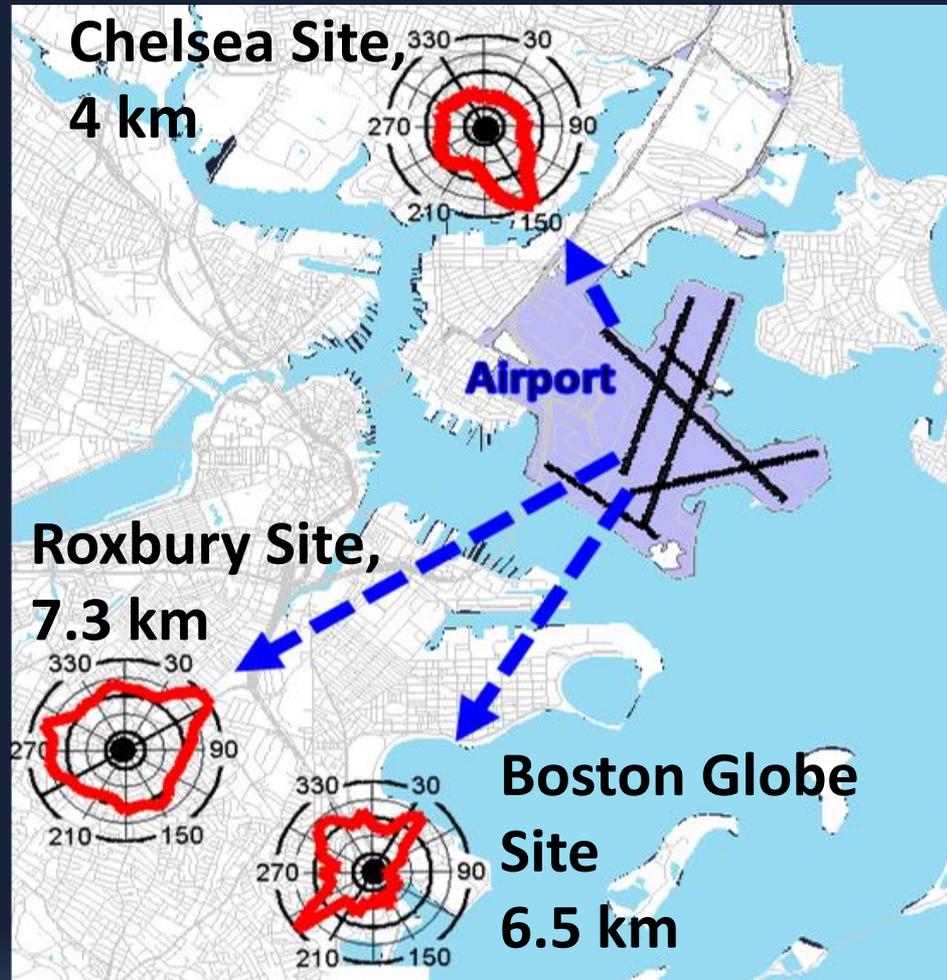
Long-term: We studied 3 central sites

Key Findings from Boston

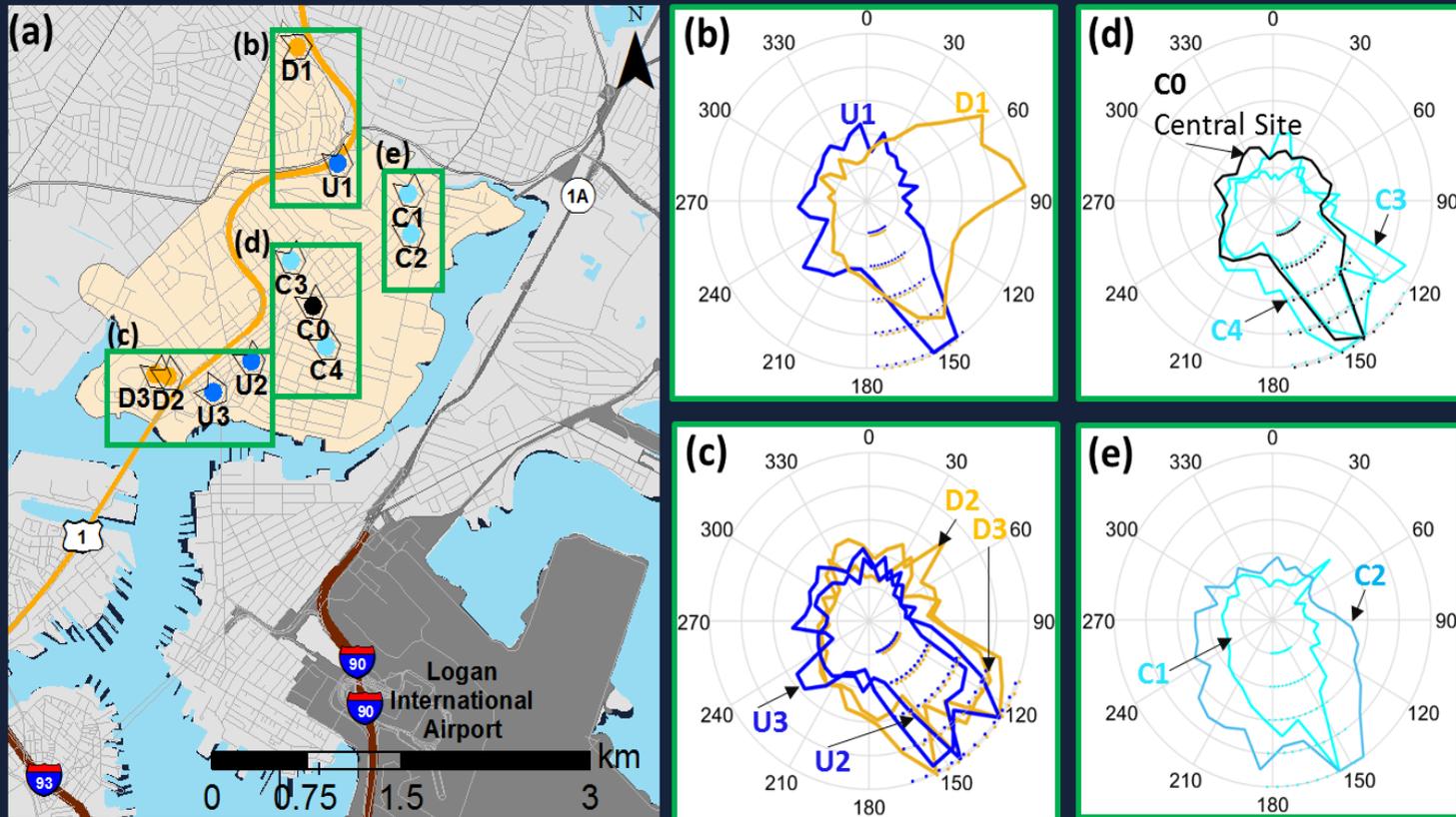
When were the concentrations highest/air-pollution worst?



Key Findings from Boston

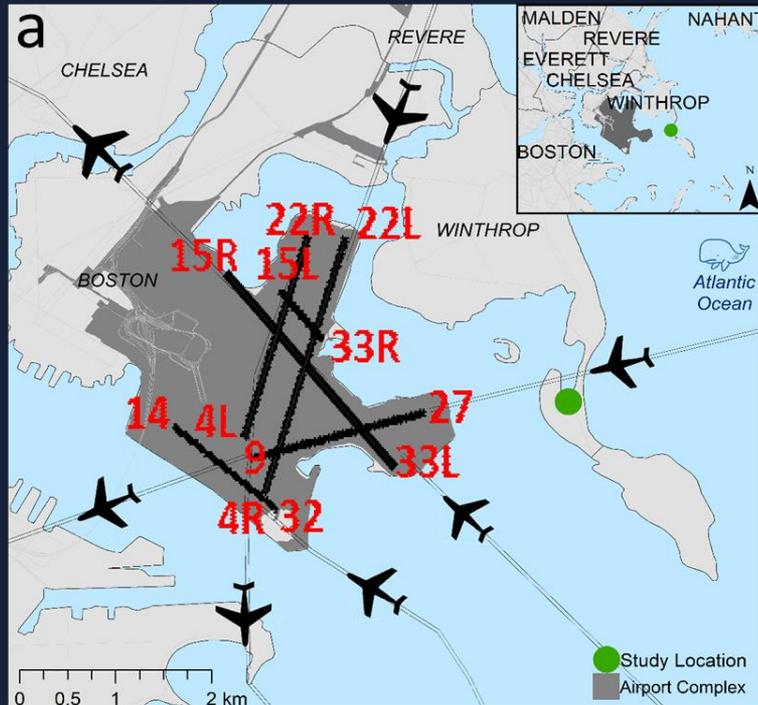


Key Findings from Boston



Key Findings from Boston

A home in a Winthrop which is situation similar to JFK-Inwood orientation and location, or Brookville, Rosedale, etc.

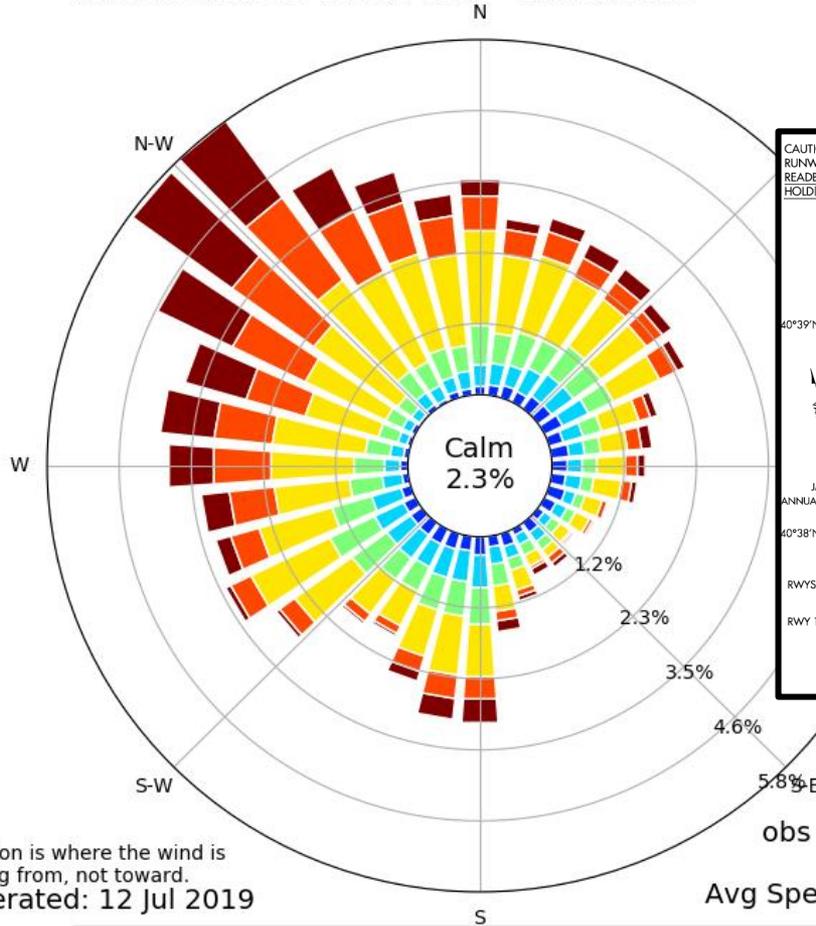


- < 1 mile from airport
- Under flight path
- Downwind a lot of the time
- Within 65dNL zone
- Soundproofed

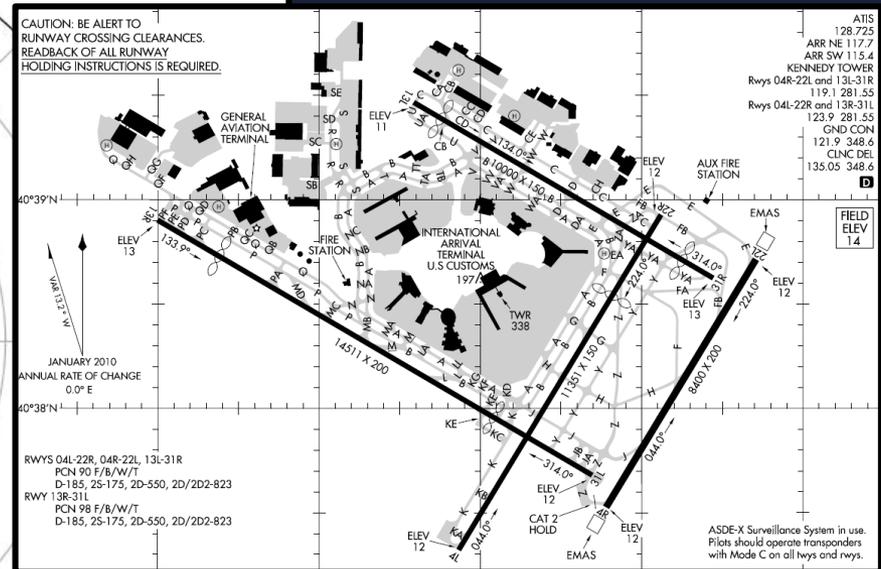
JFK: Windrose and Runway



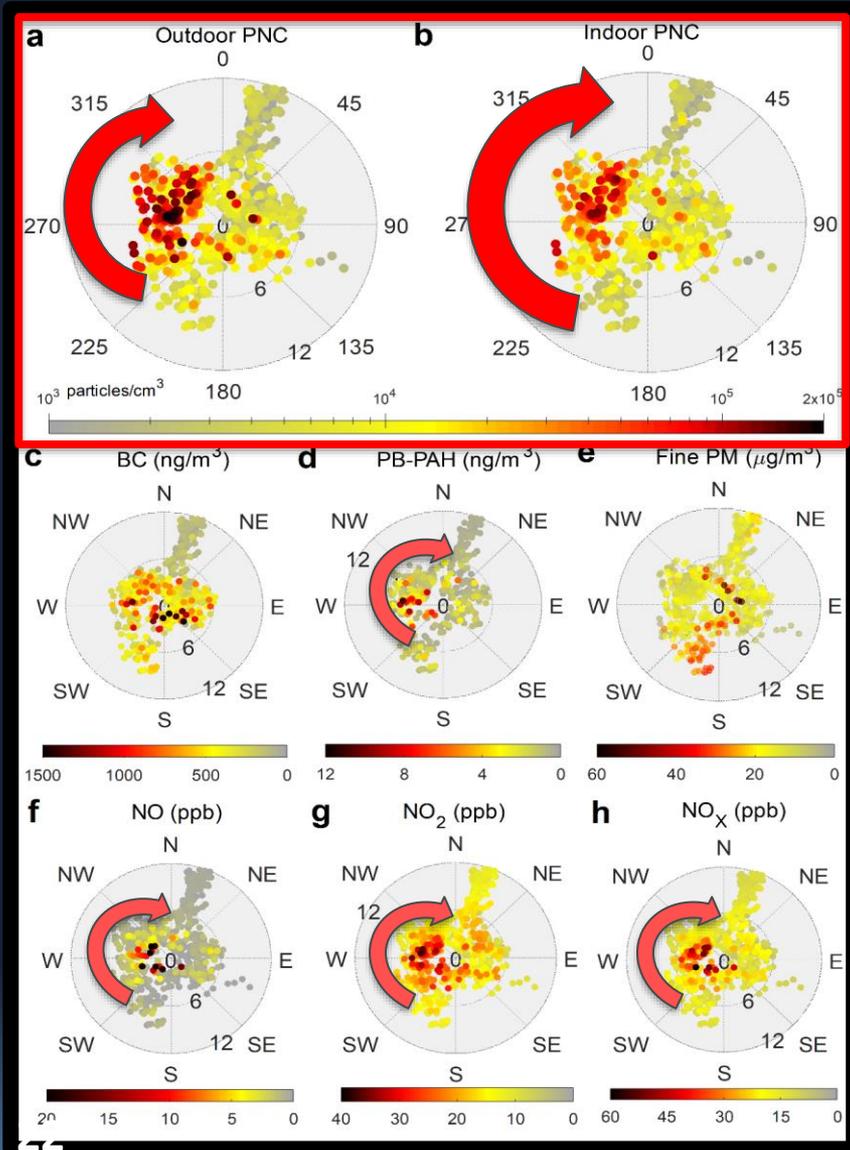
[JFK] NEW YORK/JF KENNEDY
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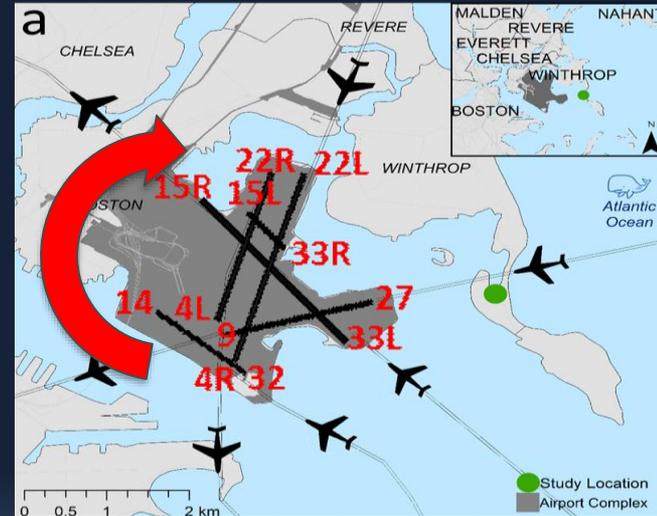
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Key Findings from Boston

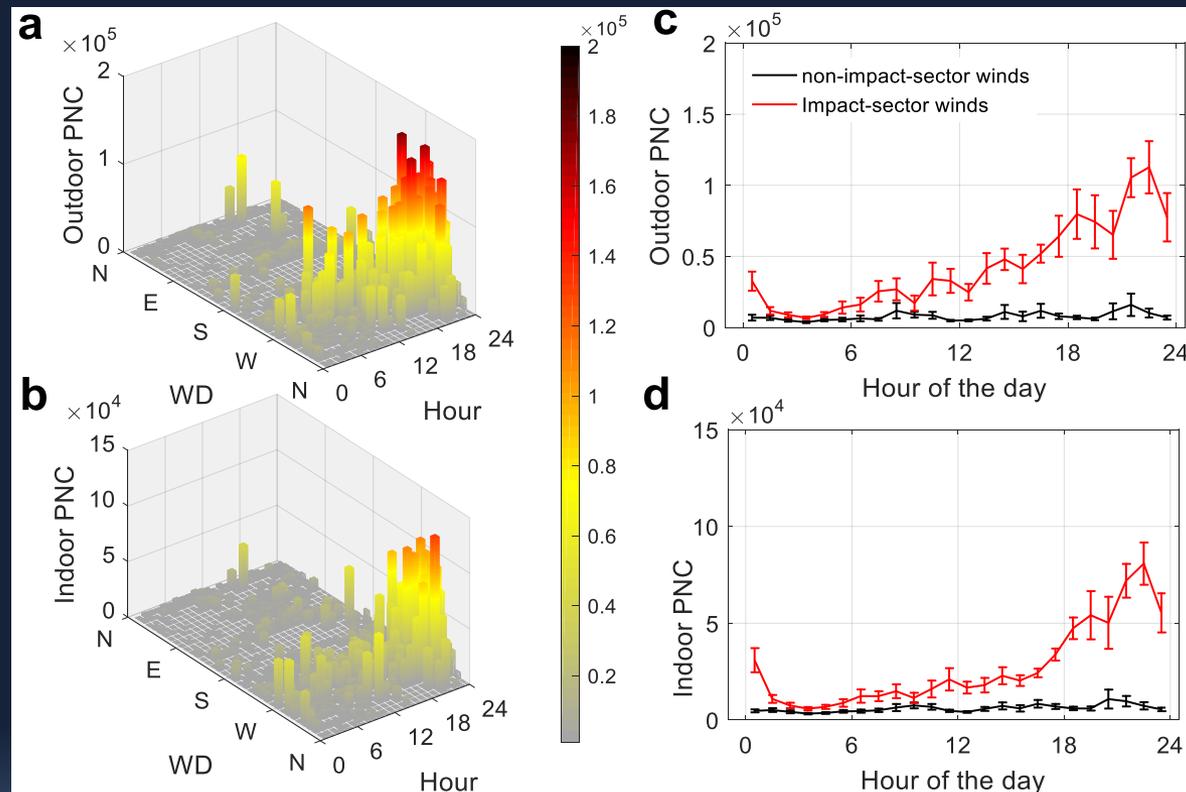


Concentrations of many pollutants highest when residence is downwind of the airport



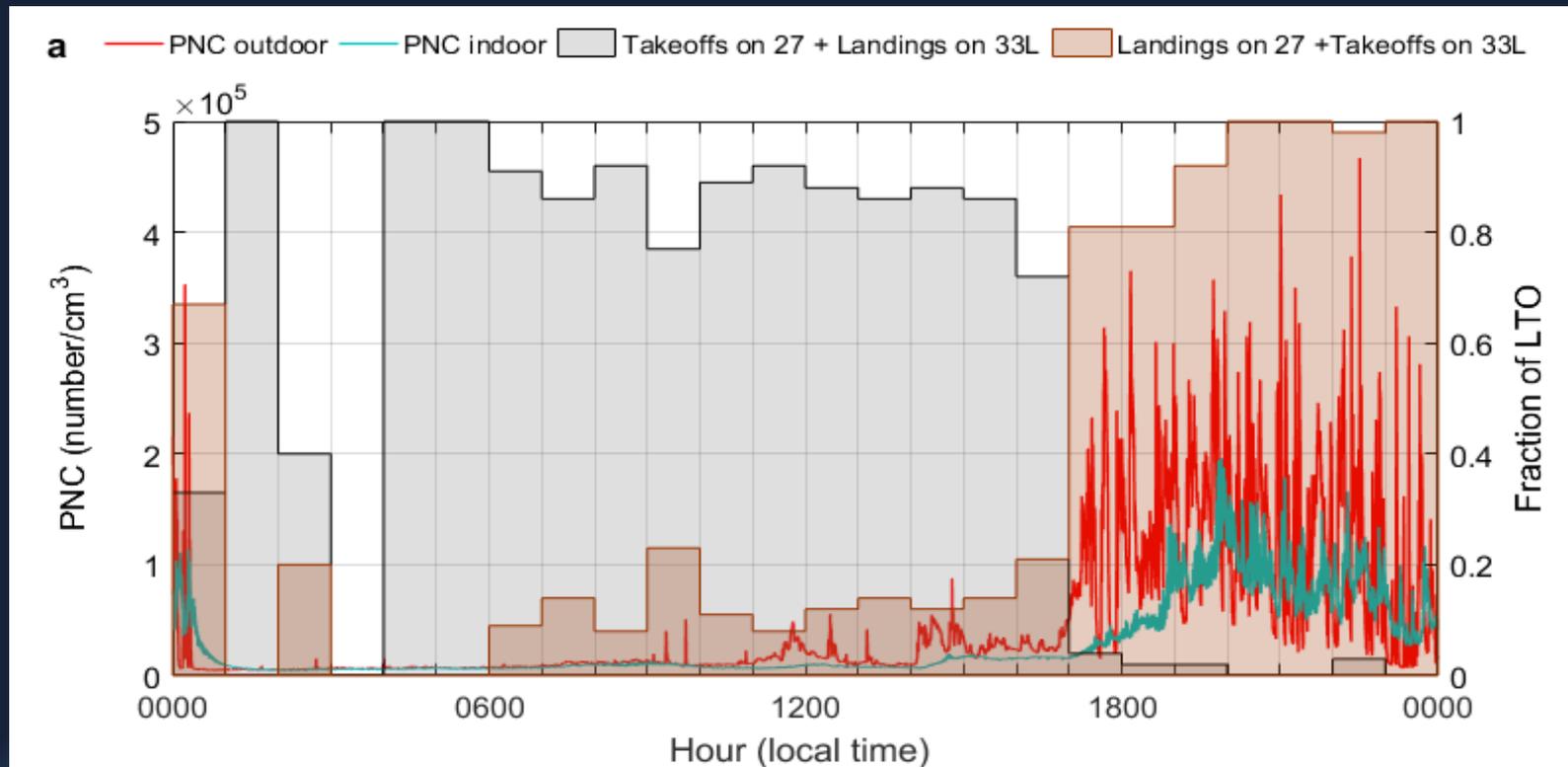
Key Findings from Boston

Indoor concentrations only 25% lower than outdoors
Highest during evening to nighttime hours



Key Findings from Boston

Concentrations highest when planes were landing overhead



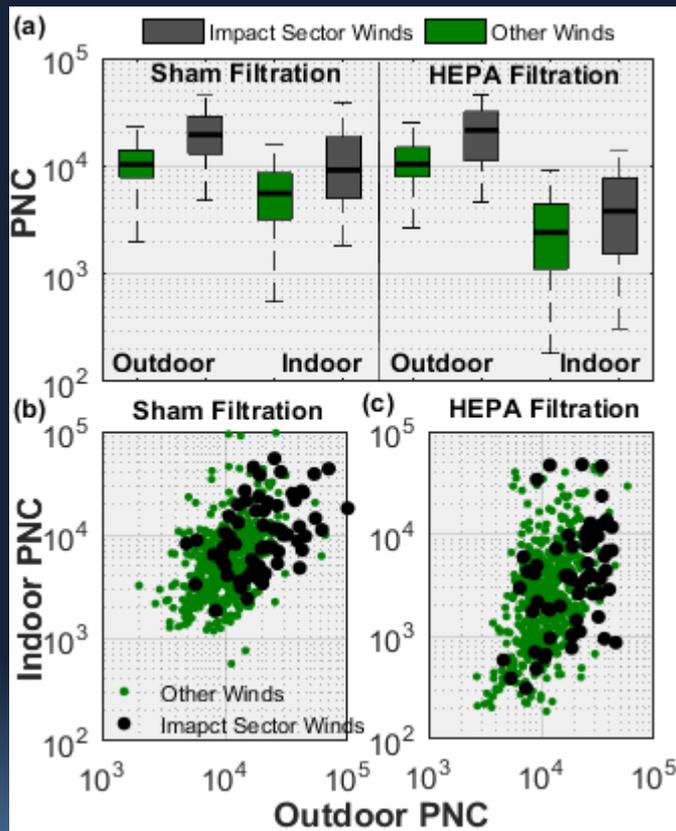
Summary and Conclusions

Our data clearly shows that in the vicinity of airports exposure to pollutants, particularly UFP and NO_2 , is as significant in magnitude as that observed in the vicinity of highways.

Our results provide a basis for systematically investigating and discussing air-pollution exposure and its abatement/mitigation in airport vicinity.

What can be done?

One really good idea is filtration (standalone or central).



Also,
- good + informed practices
for ventilation

LOTS TO BE DONE.

What needs to be done for the community?



MAPPING & TRACKING AIRPLANE NOISE

Measuring | Scaling | Understanding

Tae Hong Park, Ph.D.

New York University

www.getnoisy.io

January 2020

Modern Noise Pollution

- Global issue

2015: 50% live around urban centers

2050: ~70% will live around urban centers



Modern Noise Pollution

- Health impact

Global phenomenon negatively affecting residents and families

Cardiovascular complications, productivity, children's learning, sleep deprivation, property devaluation, ...

- Airplane noise

"Most annoying amongst transportation groups" [1].

[1] H. Miedema and H. Vos, "Exposure-response relationships for transportation noise," *J. Acoust. Soc.*, 1998.

Mapping & Tracking

Airplane Noise

Measuring | Scaling | Understanding

Data

you can't fix what you
can't measure

bigger [data] is better

seeing [&hearing] is believing



Community

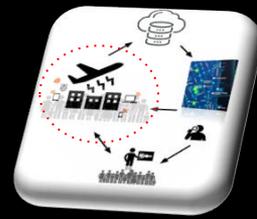
measurements at
the source

scaling & adoptability

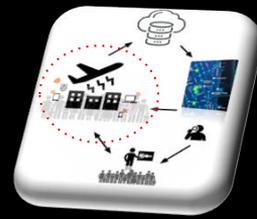
understanding & education

1. You can't fix what you can't measure

- Launched in 2011 – Citygram Project
- 9 years of research and development
- Over 25 publications and patent applications
- From lab to real world: NOISY



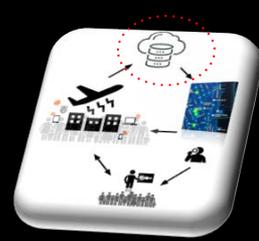
1. You can't fix what you can't measure



- Noise measurement at *source*
- *plug-and-sense* sensor network system
- High value, low bandwidth data
- Inclusive design philosophy
 - (1) accessible window
 - (2) home WiFi
 - (3) electrical outlet

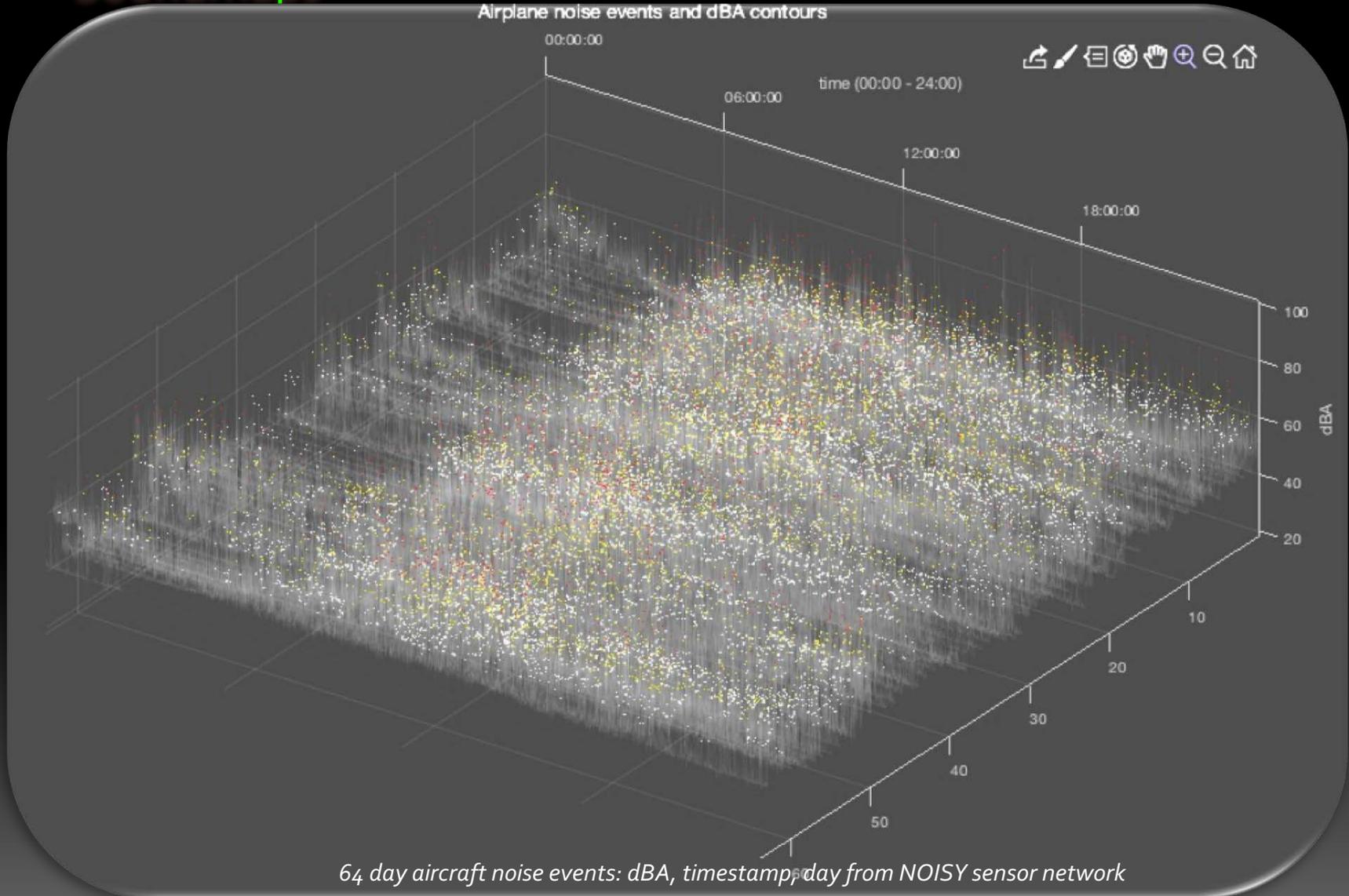
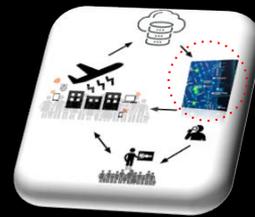
2. Bigger [Data] is Better

- Community-driven scaling
- 24/7, 365, 1 sec
- High value, low bandwidth data
- Artificial Intelligence (AI)
 - Automatic airplane noise detection
 - Ignores all other noise types



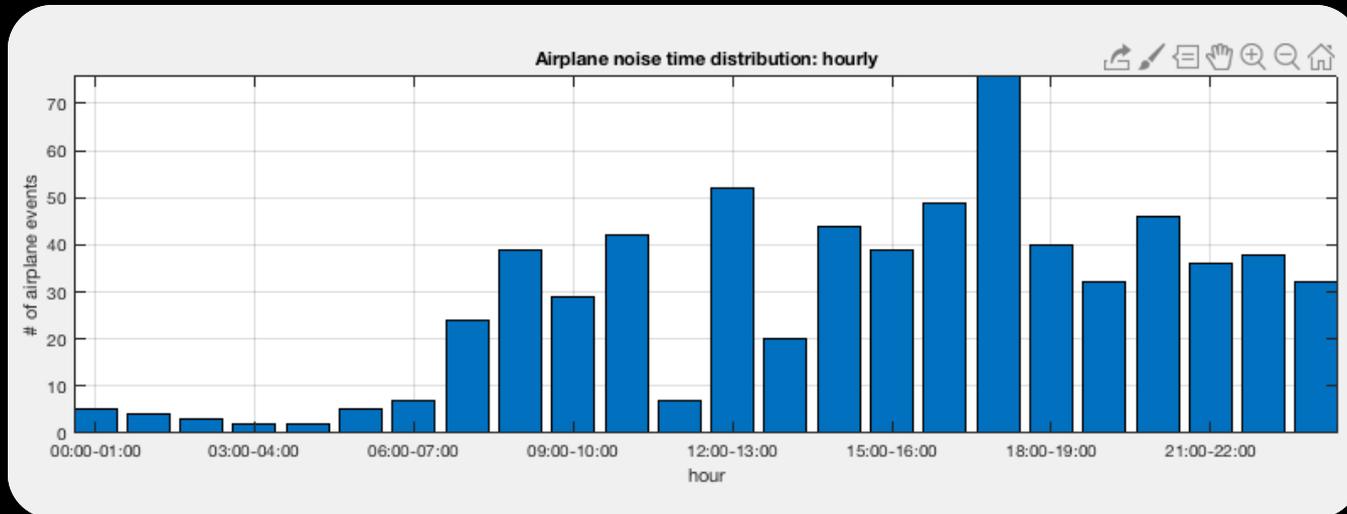
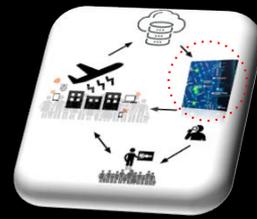
2. Seeing is Believing

Soundmaps



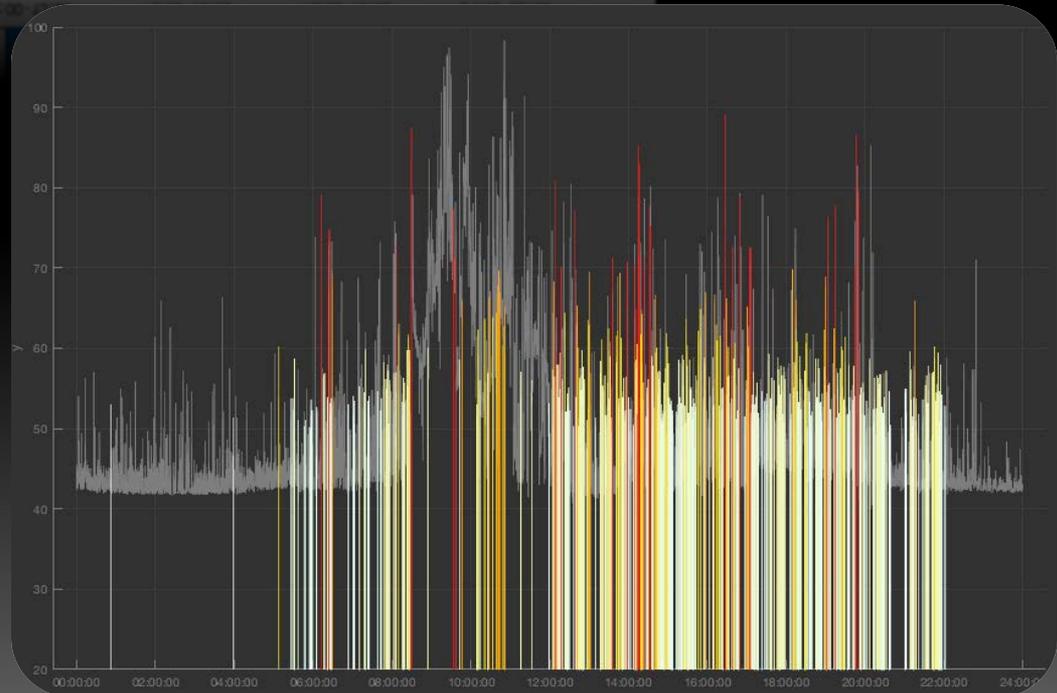
64 day aircraft noise events: dBA, timestamp, day from NOISY sensor network

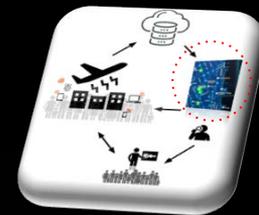
Robustness, objectivity, reliability



Hourly distribution example from NOISY sensor

24-hour airplane event (ORD)





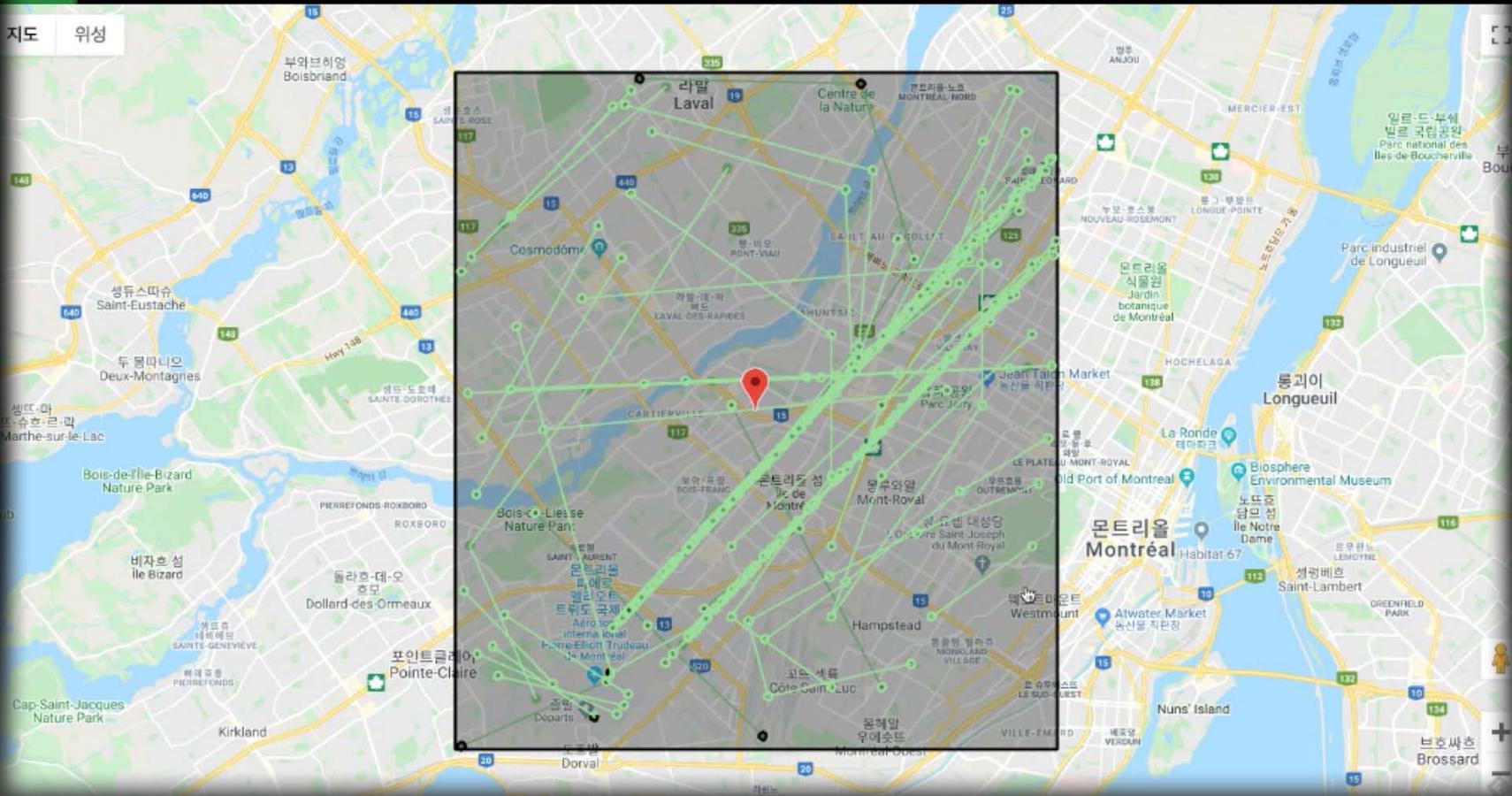
at: 0.08 dLng: 0.1 Request

me Window: 60 sec.

me Interval: 60 sec. Get Data Periodically

Show Paths

지도 위성



NOISY airplane tracking software module



Automatic airplane noise event tracking

dBA (+ additional acoustic feature options)

Date and time of event

Latitude, longitude, altitude

Airplane type & airline

Speed

Verification

Noise triangulation

ADS-B

Visualizations: current and historical data

web browser



Towards Airplane **Noise Assessment Modernization**

Community-Driven

Data-Driven

Existing *models* augmented with **measurements**

Rapid scaling and spatiotemporal granularity

Automation and AI

Adoptable at (almost) any airport and community

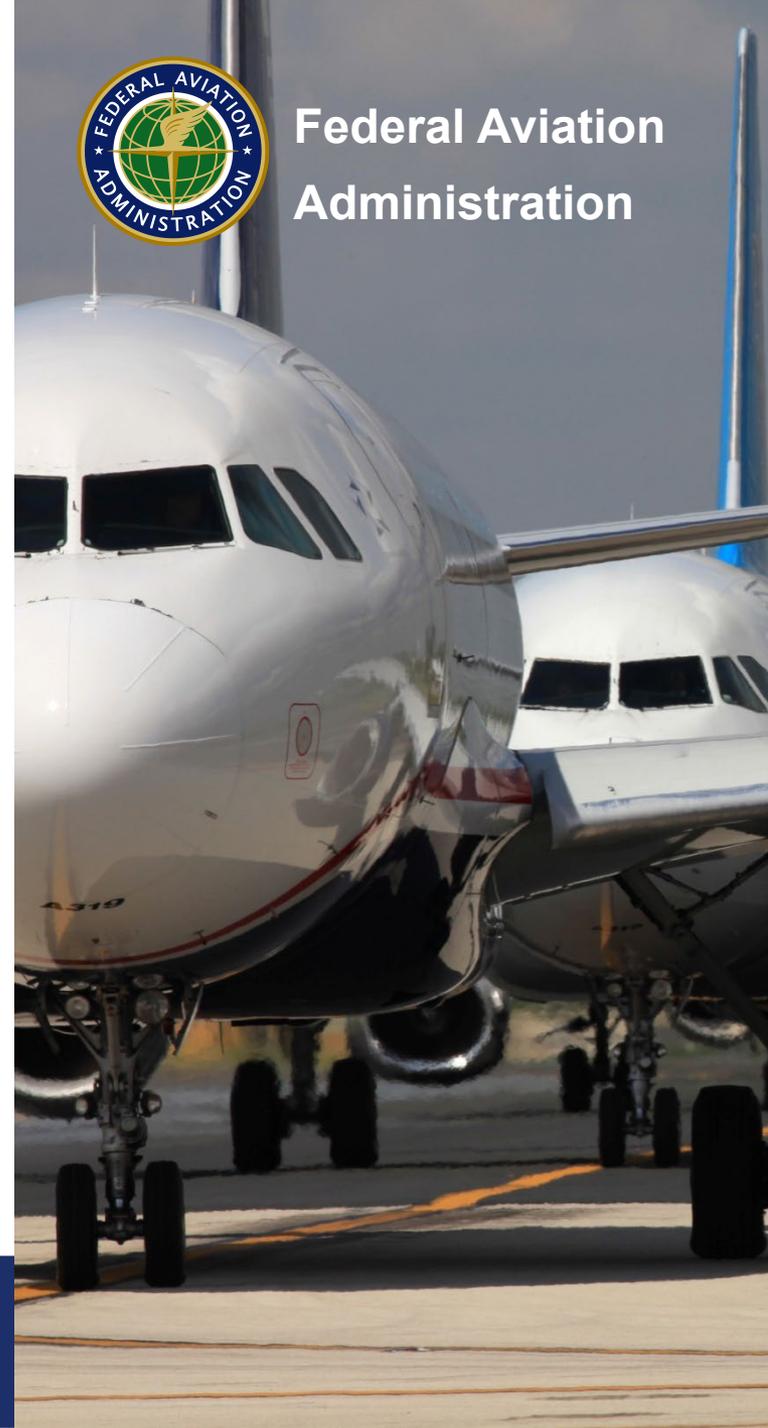
Northeast Corridor (NEC) Initiative

Overview Briefing & Flight Path Changes

- Presented to: NYCAR
- Date: January 22, 2020



Federal Aviation
Administration



Northeast Corridor Initiative Background

- On February 22, 2017, the NextGen Advisory Committee (NAC) voted to make the Northeast Corridor (NEC) a priority region in the FAA's ongoing implementation of NextGen
- NAC members recognized that continuous improvements to the system in the NEC operationally benefits the entire US aviation system
 - **~50% of the delays across the system emanate from this area**
- The NEC is defined as the region between Washington, D.C., and Boston, including Philadelphia and the New York metropolitan area
- Commitment milestones are intended to address the highest priority operational needs for the NEC from October 2017 through December 2021



NEC Goals & Objectives

- **Improve the traveler experience through better execution of today's operation**
 - Operate the full intended operation (reduce cancellations)
 - Operate on time
 - Operate predictably
- **Enhanced airport and airspace throughput in all weather conditions**
 - Adverse weather is a major issue in accomplishing most goals
- **Good for the environment: noise mitigation and reduced emissions**



NEC Scope – What is included?

- **Airspace and Procedures**: design and evaluate operational procedures that improve efficiency of today's airspace/airport operation; explore opportunities to deconflict traffic between close-in airports
- **Tools / Technology**: deploy new automation capabilities, decision support tools, and processes that enhance controller information and decision-making such that operational performance is improved in all operating conditions
- **Tactical Initiatives**: maximize and evolve the utilization of already deployed tools, routes, and processes to improve movement of air traffic into, out of, and within the NEC during periods of exceptionally high demand and severe weather
- **Airports**: build airport infrastructure on the airport surface, airport terminal buildings, and air traffic towers that enable improved surface operations and airport throughput



Northeast Corridor Initiative Airspace & Procedures Milestones Status

	FAA	Industry	Airports	Totals
Total Milestones	51	41	12	104
Completed Milestones	40	10	4	54

- 10 FAA milestones open for CY2020
- 1 FAA milestone open for CY2021
- Some milestones are concept assessments or feasibility studies that may lead to implementation



NEC Flight Path Changes for 2020

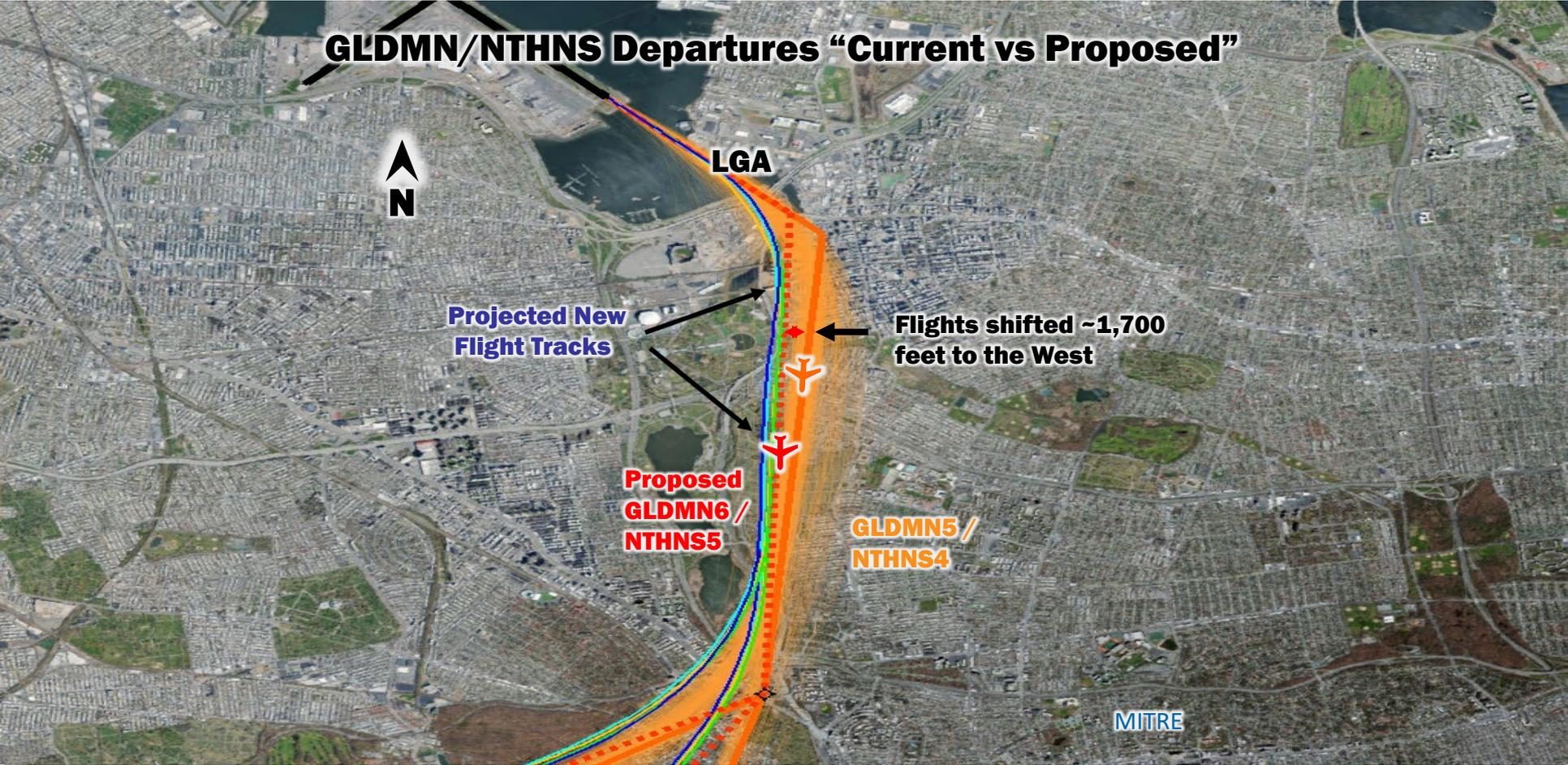


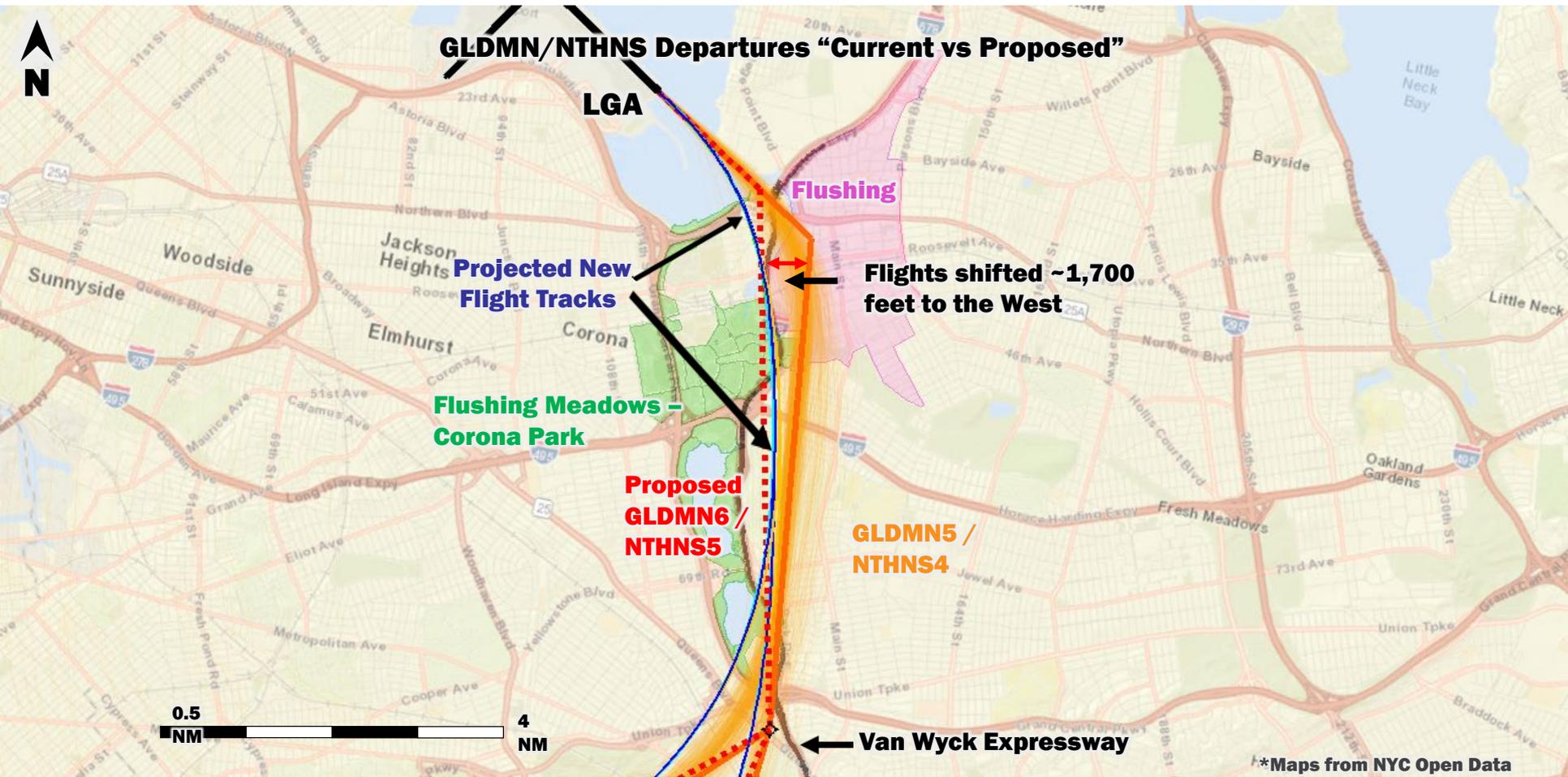
NTHNS/GLDMN Departures

- **The proposed NTHNS/GLDMN aircraft procedure amendment would enhance safety and efficiency over the current procedure design**
- **Aircraft shift west of downtown Flushing and traverse more directly over the Van Wyck Expressway**
- **Environmental review ongoing**
- **Procedure amendment anticipated publication date May 21, 2020**

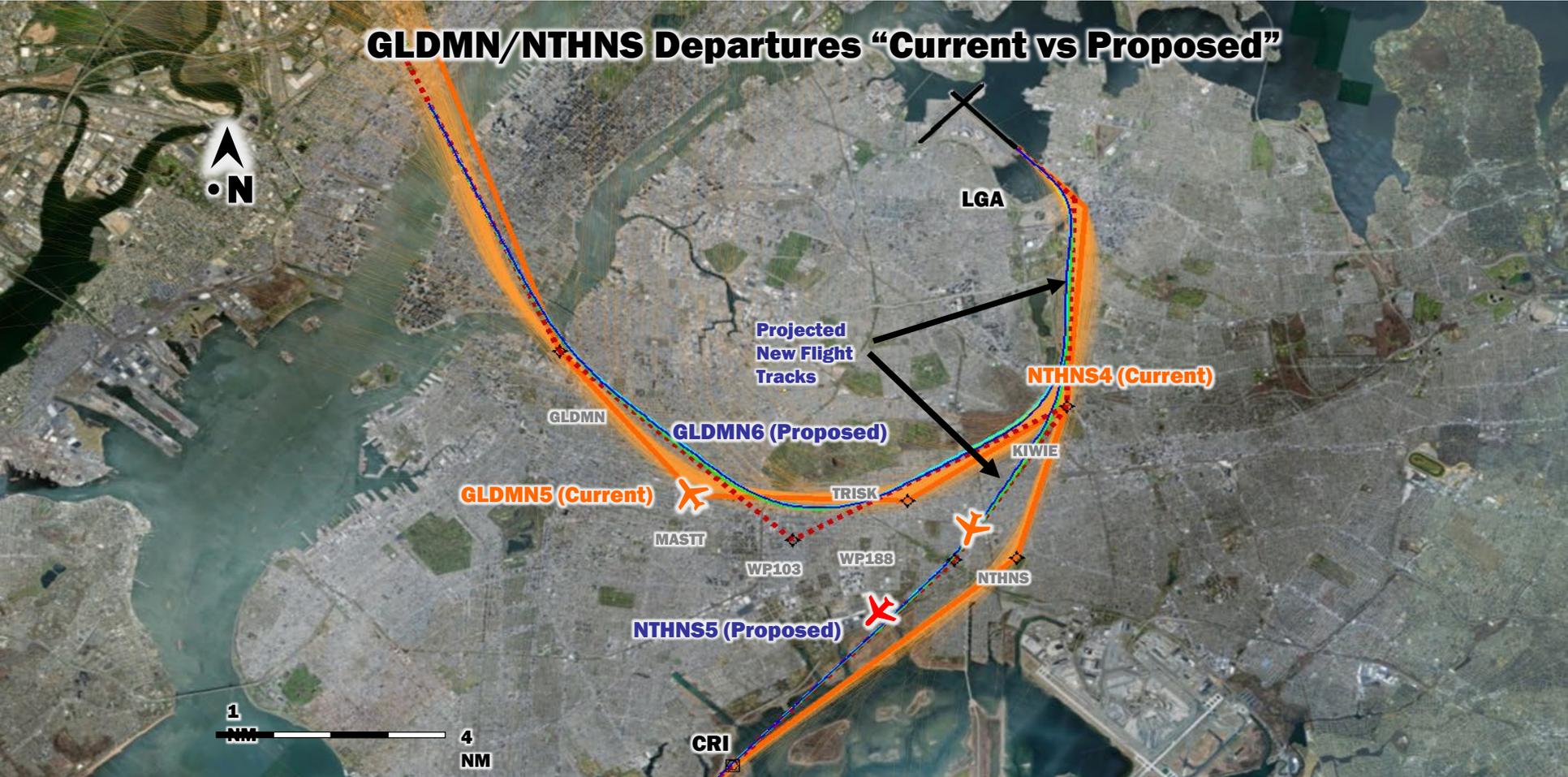


GLDMN/NTHNS Departures "Current vs Proposed"

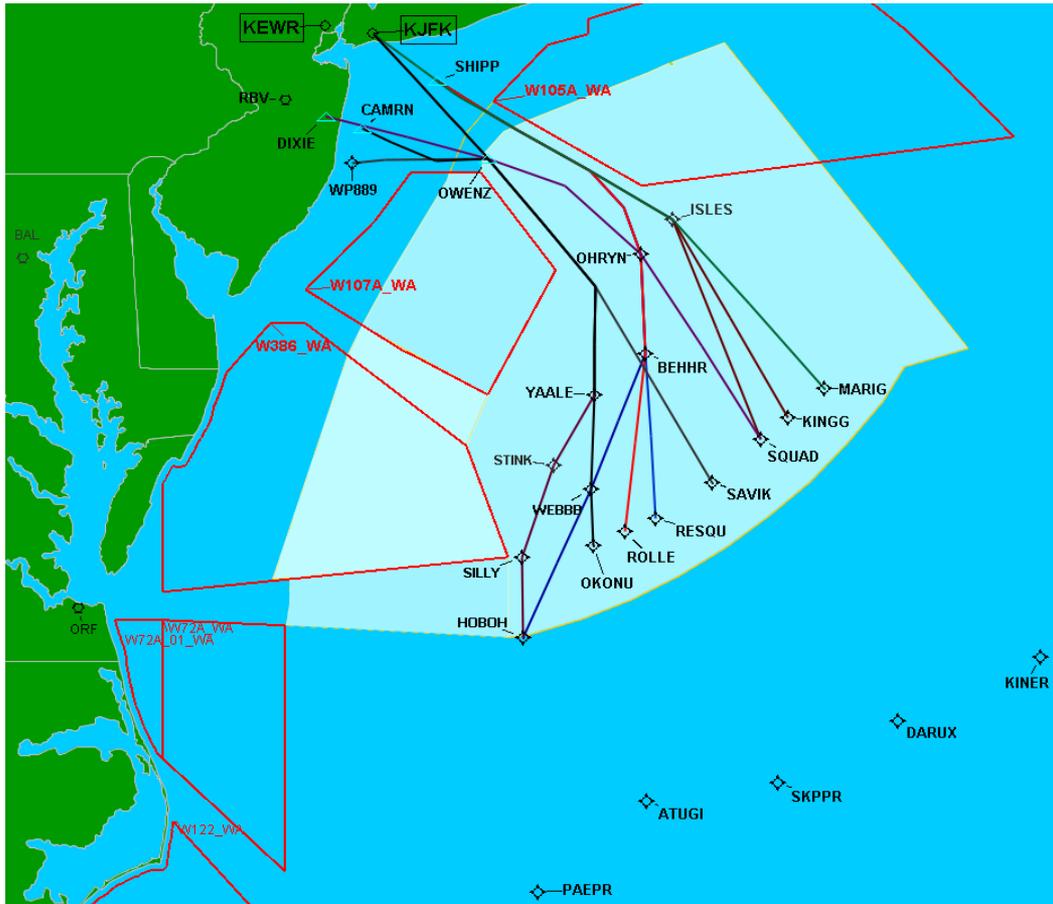




GLDMN/NTHNS Departures "Current vs Proposed"



NEC Initiative: Implement Satellite-Based Route Structure in Offshore Airspace East of NY



Project Scope:

Redesign airspace and route structure in offshore airspace east of New York

Expected Outcomes:

Increase offshore airspace capacity via additional sector and segregation of flows in tight airspace between Warning Areas



NEC Initiative: East Coast Satellite-Based (PBN) High-Altitude Routes

Initiative Objective

Design high-altitude (above 24,000 ft) PBN Route structure to segregate flows and better manage traffic to/from major airports on East Coast

Northeast Corridor

Mid-Atlantic States to New England

- Implementation September 2020

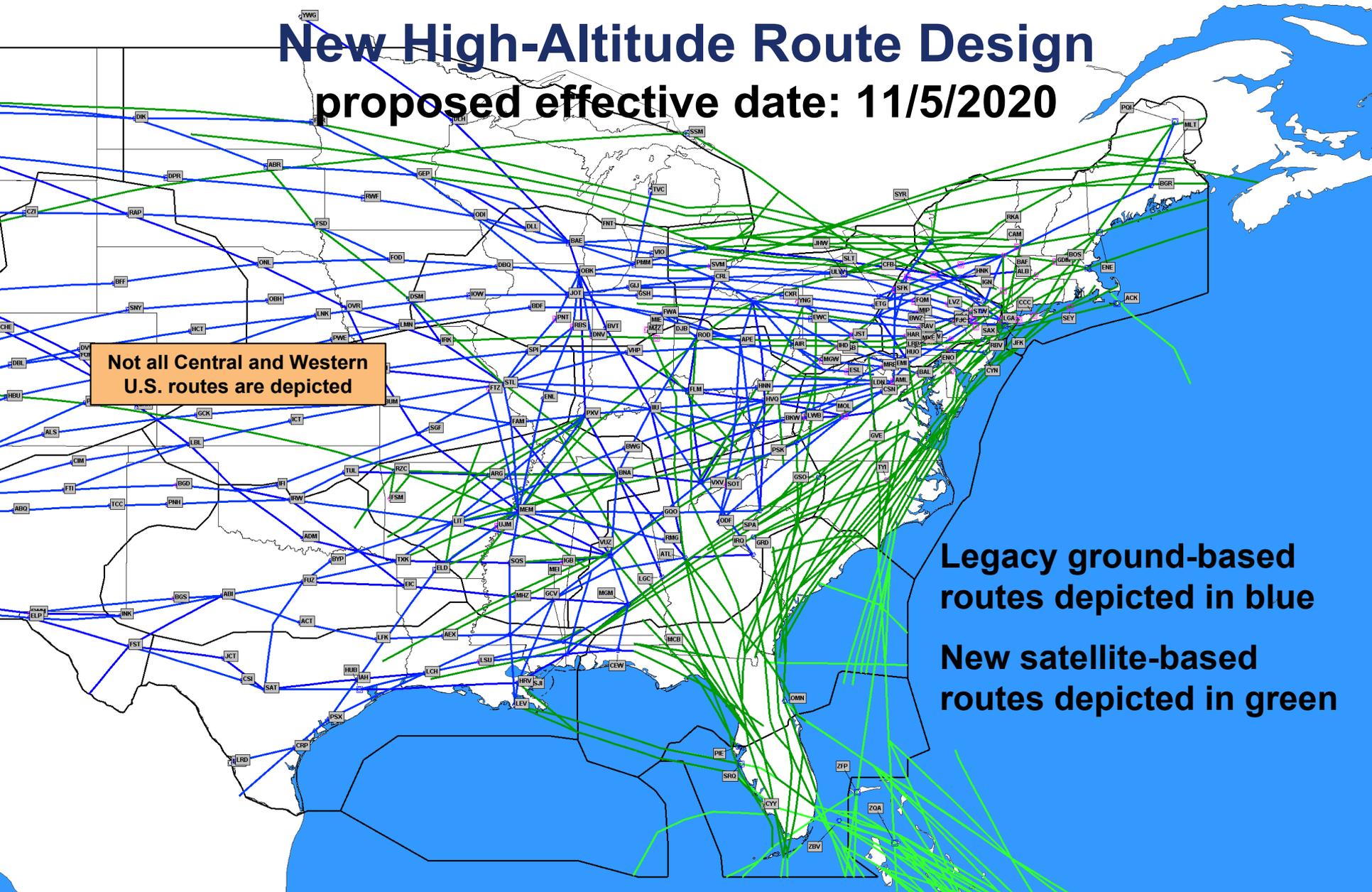
Florida Metroplex

Southern States to Puerto Rico

- Implemented November 2018



New High-Altitude Route Design proposed effective date: 11/5/2020



Thank you!

We will continue to keep you and your communities updated

*Please follow the link below to view the latest report titled
“Phase 2 Addendum to Priorities for Improving Operational
Performance in the Northeast Corridor (NEC) through CY2021”*

*Approved by the
NextGen Advisory Committee in June 2018*

https://www.faa.gov/about/office_org/headquarters_offices/ang/nac/media/NEC_Report_Jun2018.pdf



FAA Reauthorization Act of 2018

→ Signed into law by President Trump on Oct. 5, 2018

Title I – Authorizations

Subtitle D – Airport Noise and Environmental Streamlining

Sec. 173

Alternative airplane noise metric evaluation deadline

- No later than 1 year after date of enactment of this act the FAA shall complete the ongoing evaluation of alternative metrics to the current Day Night Level (DNL) 65 standard.

Sec. 175

Addressing community noise concerns

- When proposing a new area navigation departure procedure, or amending an existing procedure that would direct aircraft between the surface and 6,000 feet above ground level over noise sensitive areas, the Administrator of the Federal Aviation Administration shall consider the feasibility of dispersal headings or other lateral track variations to address community noise concerns.

Sec. 176

Community involvement if FAA NextGen projects located in metroplexes

- Not later than 180 days after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall complete a review of the Federal Aviation Administration's community involvement practices for Next Generation Air Transportation System (NextGen) projects located in metroplexes identified by the Administration. The review shall include, at a minimum, a determination of how and when to engage airports and communities in performance-based navigation proposals.
- Report - Not later than 60 days after completion of the review, the Administrator shall submit to the appropriate committees of Congress a report on—
 - ✓ how the Administration will improve community involvement practices for NextGen projects located in metroplexes;
 - ✓ how and when the Administration will engage airports and communities in performance-based navigation proposals; and
 - ✓ lessons learned from NextGen projects and pilot programs and how those lessons learned are being integrated into community involvement practices for future NextGen projects located in metroplexes

FAA Reauthorization Act of 2018

Sec. 177

Lead emissions

- Study - The Secretary of Transportation shall enter into appropriate arrangements with the National Academies of Sciences, Engineering, and Medicine under which the National Research Council will study aviation gasoline.
- The study shall include an assessment of—
 - ✓ existing non-lead fuel alternatives to the aviation gasoline used by piston-powered general aviation aircraft;
 - ✓ ambient lead concentrations at and around airports where piston-powered general aviation aircraft are used; and
 - ✓ mitigation measures to reduce ambient lead concentrations, including increasing the size of run-up areas, relocating run-up areas, imposing restrictions on aircraft using aviation gasoline, and increasing the use of motor gasoline in piston-powered general aviation aircraft.
- Report – not later than 1 year after the date of enactment of this Act, the Secretary shall submit to the appropriate committees of Congress the study developed by the National Research Council pursuant to this section.

Sec. 178

Terminal sequencing and spacing

- Not later than 60 days after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall provide a briefing to the appropriate committees of Congress on the status of Terminal Sequencing and Spacing (TSAS) implementation across all completed NextGen metroplexes with specific information provided by airline regarding the adoption and equipping of aircraft and the training of pilots in its use.

Sec. 179

Airport noise mitigation and safety study

- Not later than 1 year after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall initiate a study to review and evaluate existing studies and analyses of the relationship between jet aircraft approach and takeoff speeds and corresponding noise impacts on communities surrounding airports.
- Considerations - In conducting the study the Administrator shall determine—
 - ✓ whether a decrease in jet aircraft approach or takeoff speeds results in significant aircraft noise reductions;
 - ✓ whether the jet aircraft approach or takeoff speed reduction necessary to achieve significant noise reductions
 - ✓ if it jeopardizes aviation safety
 - ✓ decreases the efficiency of the National Airspace System, including lowering airport capacity, increasing travel times, or increasing fuel burn;

FAA Reauthorization Act of 2018

- ✓ the advisability of using jet aircraft approach or takeoff speeds as a noise mitigation technique; and
- ✓ if the Administrator determines that using jet aircraft approach or takeoff speeds as a noise mitigation technique is advisable, whether any of the metropolitan areas specifically identified in section 189(b)(2) would benefit from such a noise mitigation technique without a significant impact to aviation safety or the efficiency of the National Airspace System.
- Report - Not later than 2 years after the date of enactment of this Act, the Administrator shall submit to the appropriate committees of Congress a report on the results of the study initiated.

Sec. 180

Regional ombudsmen

- Not later than 1 year after the date of enactment of this Act, with respect to each region of the Federal Aviation Administration, the Regional Administrator for that region shall designate an individual to be the Regional Ombudsman for the region.
- Requirements:
 - ✓ serve as a regional liaison with the public, including community groups, on issues regarding aircraft noise, pollution, and safety;
 - ✓ make recommendations to the Administrator for the region to address concerns raised by the public and improve the consideration of public comments in decision-making processes; and
 - ✓ be consulted on proposed changes in aircraft operations affecting the region, including arrival and departure routes, in order to minimize environmental impacts, including noise.

Sec. 182

Mandatory use of the New York North Shore Helicopter Route

- Review
 - ✓ Not later than 30 days after the date of enactment of this Act, the Administrator shall initiate a review of the regulations described in subsection (a)(1) that assesses the—
 - ✓ noise impacts of the regulations for communities, including communities in locations where aircraft are transitioning to or from a destination or point of landing;
 - ✓ enforcement of applicable flight standards, including requirements for helicopters operating on the relevant route to remain at or above 2,500 feet mean sea level; and
 - ✓ availability of alternative or supplemental routes to reduce the noise impacts of the regulations, including the institution of an all water route over the Atlantic Ocean.

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Sec. 186

Stage 3 aircraft study

- Study - No later than 180 days after the date of enactment of this Act, the Comptroller General of the United States shall initiate a review of the potential benefits, costs and other impacts that would result from a phase-out of covered stage 3 aircraft.
- Report – Not later than 18 months after the date of enactment of this Act, Comptroller General shall submit to the appropriate committees of Congress a report on the results of the review.

Sec. 187

Aircraft noise exposure

- The Administrator of the FAA shall conclude the Administrator’s ongoing review of the relationship between aircraft noise exposure and its effects on communities around the airports.
- No later than 2 years after the date of enactment of this Act, the Administrator shall submit to Congress a report containing the results of the review.

Sec. 188

Study regarding day-night average sound levels

- The Administrator of the FAA shall evaluate alternative metrics to the current average day-night level standard, such as the use of actual noise sampling and other methods to address community airplane noise concerns.
- Report – Not later than 1 year after the date of enactment of this Act, the Administrator shall submit to the appropriate committees of Congress a report on the results of the study.

Sec 189

Study on potential health and economic impacts of overflight noise

- Not later than 180 days after the date of enactment of this Act, the Administrator of the Federal Aviation Administration shall enter into an agreement with an eligible institution of higher education to conduct a study on the health impacts of noise from aircraft flights on residents exposed to a range of noise levels from such flights.
 - ✓ The study shall include an examination of the incremental health impacts attributable to noise exposure that result from aircraft flights, including sleep disturbance and elevated blood pressure.
 - ✓ Be focused on residents in the metropolitan areas of: Boston, Chicago, the District of Columbia, New York, the Northern California Metroplex, Phoenix, the Southern California Metroplex, Seattle

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- ✓ consider, in particular, the incremental health impacts on residents living partly or wholly underneath flight paths most frequently used by aircraft flying at an altitude lower than 10,000 feet, including during takeoff or landing;
- ✓ include an assessment of the relationship between a perceived increase in aircraft noise, including as a result of a change in flight paths that increases the visibility of aircraft from a certain location, and an actual increase in aircraft noise, particularly in areas with high or variable levels of non-aircraft-related ambient noise;
- ✓ consider the economic harm or benefits to businesses located partly or wholly underneath flight paths most frequently used by aircraft flying at an altitude lower than 10,000 feet, including during takeoff or landing.
- Institution agrees to submit to the Administrator, not later than 3 years after entering into an agreement the results of the study, including any source materials used.
- Not later than 90 days after the Administrator receives the results of the study, the administrator shall submit to the appropriate committees of Congress the study and a summary of the results.