

Aircraft Emissions and Local Air Quality: The Energy Policy Act of 2005

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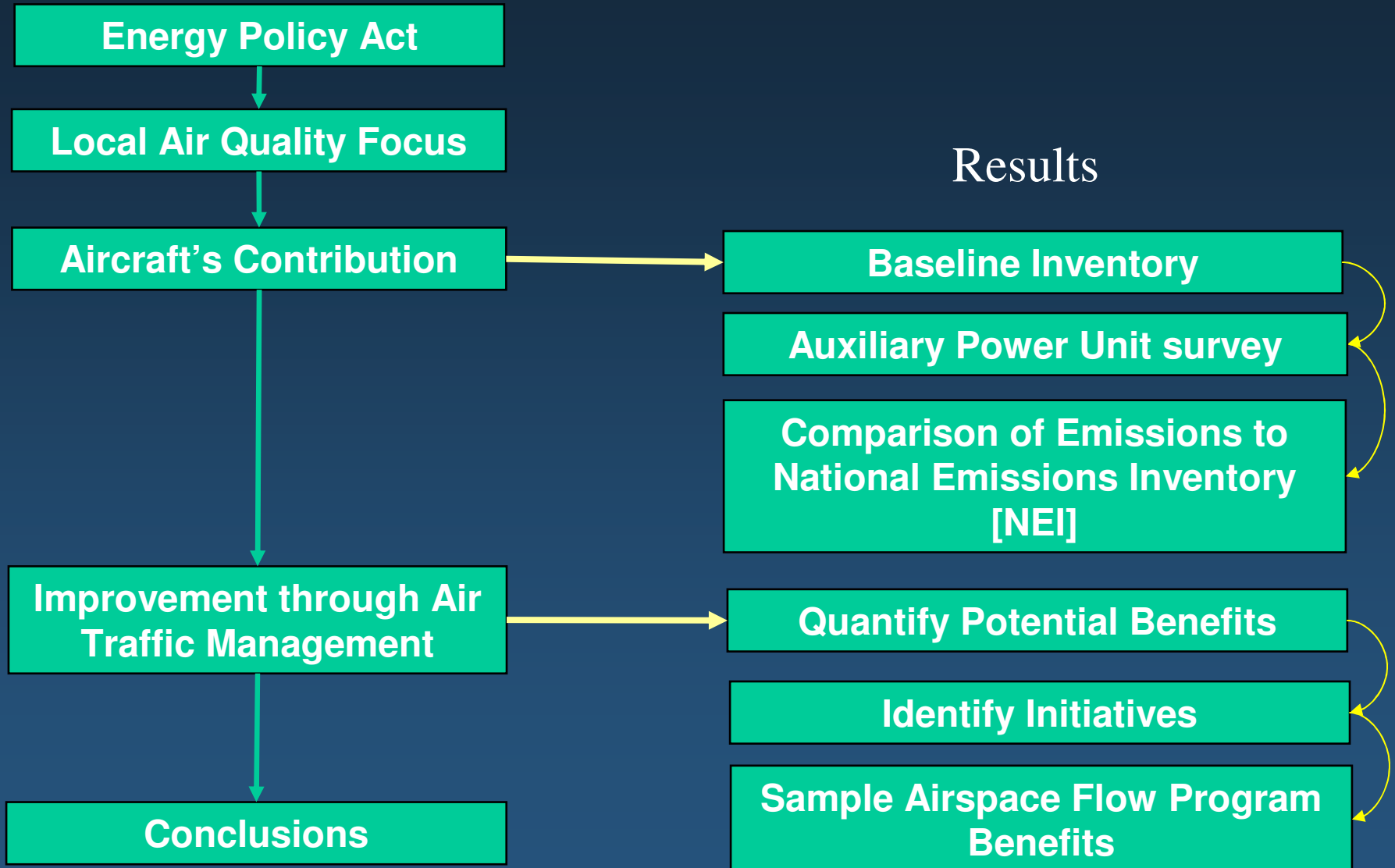


and was performed by a team that includes:

US Federal Aviation Administration, CSSI, Metron Aviation, Massachusetts Institute of Technology, US Environmental Protection Agency, and US Department of Defense

The Energy Policy Act Study is managed by Warren Gillette, FAA.

Overview



Congressional Mandate Energy Policy Act of 2005

Requires FAA and EPA to:

- ◆ Conduct a study to identify the impact of aircraft emissions in areas of poor air quality
- ◆ Identify ways to promote fuel conservation to enhance fuel efficiency and reduce emissions

Focus: Air traffic management inefficiencies

Congressional Mandate Energy Policy Act of 2005

Requires FAA and EPA to (cont.):

- ◆ Issue a report that:
 - ❖ Describes the results of the study and
 - ❖ Recommends ways to reduce fuel use and emissions affecting air quality. *

- * (1) Must not adversely affect safety and security or increase individual aircraft noise. (2) Must take into account all aircraft emissions and the impact of emissions on human health.

Local Air Quality Focus

- ◆ Energy Policy Act focuses on poor local air quality
- ◆ Based on National Ambient Air Quality Standards (NAAQS) for CO, Pb, NO₂, SO₂, PM₁₀, PM_{2.5}, and O₃
- ◆ Local air quality is effected by emissions below the mixing height (3000 feet)
- ◆ Emissions below 3000 feet focus the study to the airport level
- ◆ At the airport level, consider opportunities to improve ground based operations to decrease emissions below 3000 feet

Poor Air Quality Areas

Only one criteria pollutant must exceed standards

8-hour Ozone Standard



■ Poor Air Quality Areas

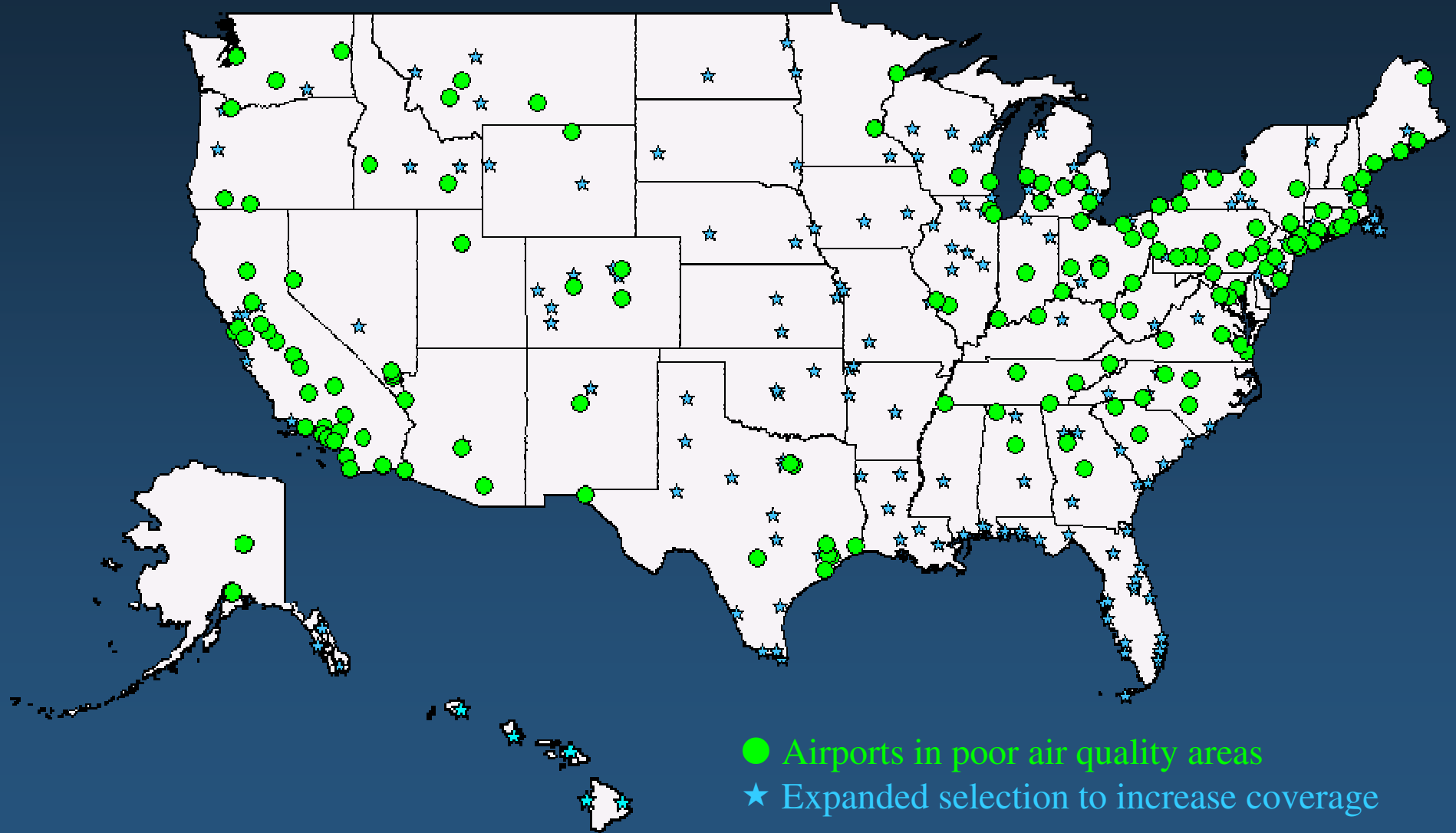
Four Analyses

1. Estimate the contribution of aircraft to emissions inventories and local air quality effects in poor air quality areas
2. Investigate the relationship between congestion, delays and aircraft emissions on local air quality
3. Estimate the potential of promising initiatives to relieve congestion and delays, reduce emissions and improve local air quality
4. Estimate health effects from aircraft emissions

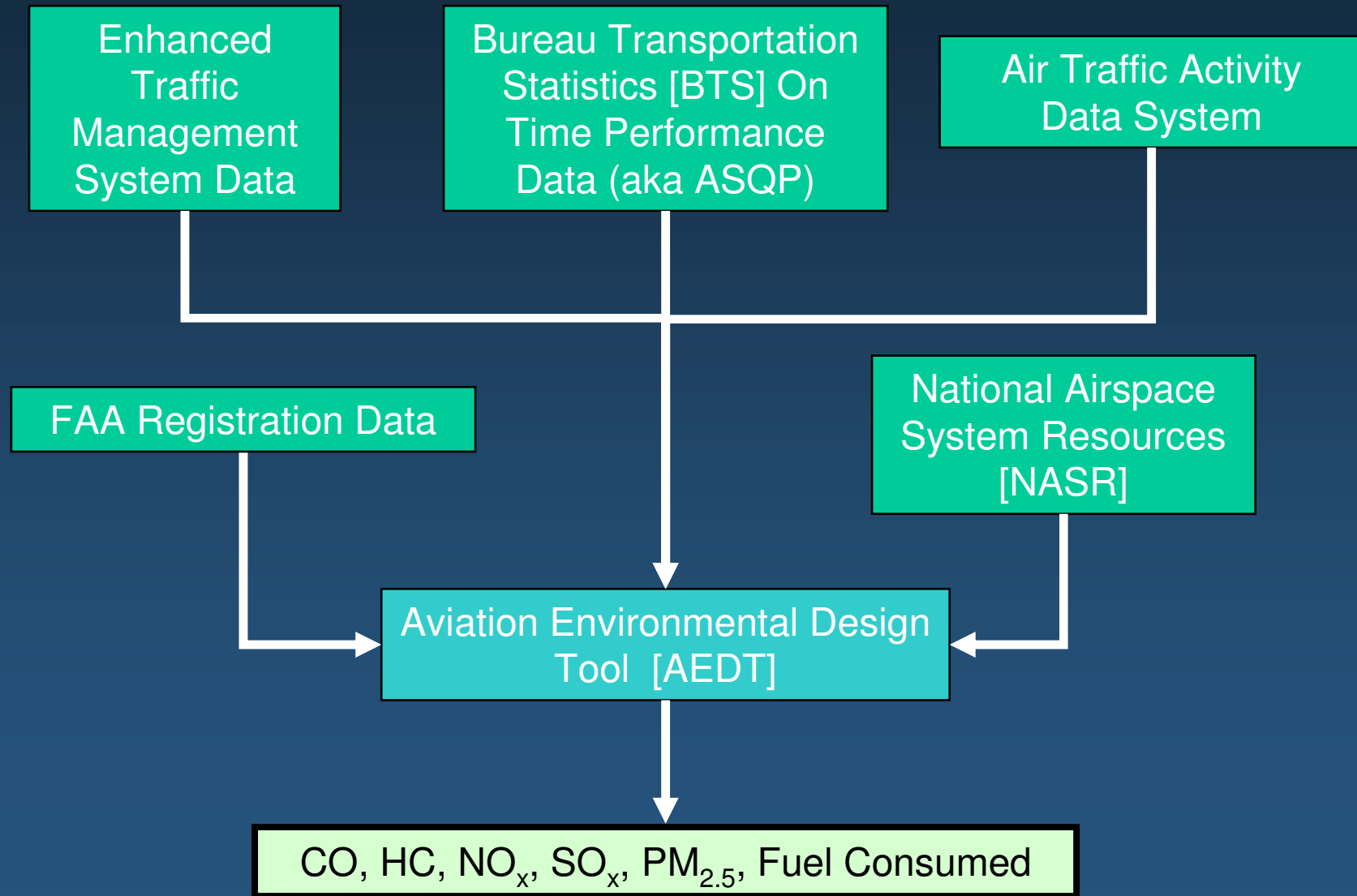
Analysis 1: Aircraft's Contribution

- ◆ Airport Selection
 - ❖ 325 airports were selected to include ~95% of commercial jet engine operations
 - ❖ 148 airports in poor air quality areas for Carbon Monoxide, Ozone or Particulate Matter
- ◆ Establish baseline inventory for fuel burn and emissions
 - ❖ Create an operational profile using as much data as possible
 - ❖ Air pollutant emissions below the atmospheric mixing height
- ◆ Evaluate effects of auxiliary power unit (APU) usage on emissions
- ◆ Determine aircraft's effect on local air quality

Selected Airports



Baseline Inventory



Auxiliary Power Unit (APU) Survey

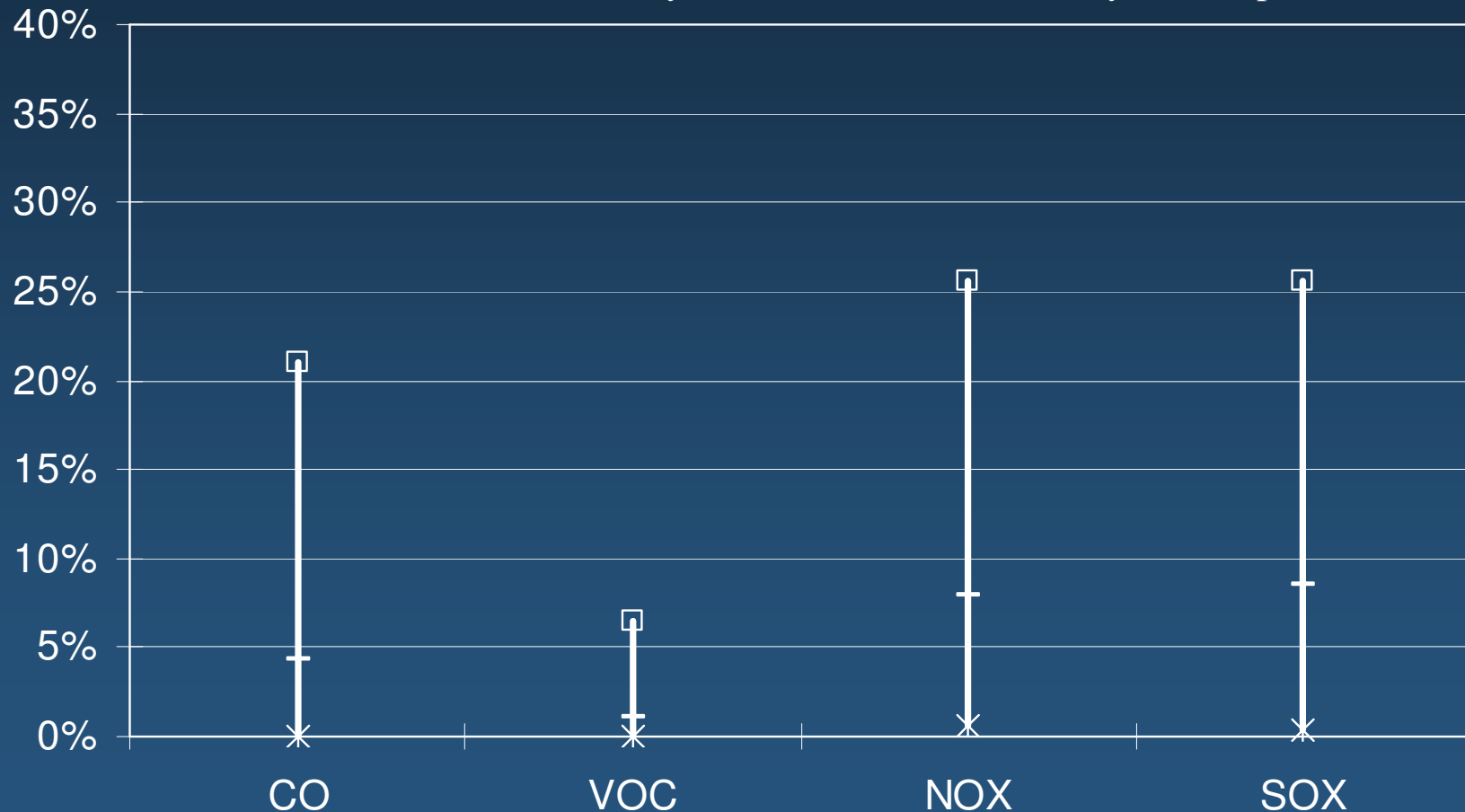
- ◆ APU Usage is not reported
- ◆ Depends on the availability of powered gates
- ◆ Usage ultimately rests with the pilot
- ◆ Interviewed carriers to better model usage
 - ❖ Proprietary carrier specific data
 - departure preparations · arrival taxi
 - departure taxi · gate arrival

Minutes of APU Usage per LTO					
Narrow Body			Wide Body		
Lower	Medium	Upper	Lower	Medium	Upper
31	48	65	96	130	163

APU Effects – Medium Minutes of Use (325 Airports)

Range of the percentage of Aircraft Emissions due to APU

Medium Use: 48 mins for narrow body and 130 mins for wide body aircraft per LTO



□ Maximum – Average × Minimum

Emissions Results

- ◆ Aggregated to airport emissions by month and mode
 - ❖ Mode can be allocated to height for health impact analysis
- ◆ Reported Pollutants:
 - ❖ Carbon Monoxide (CO)
 - ❖ Nitrogen Oxides (NO_x)
 - ❖ Sulfur Oxides (SO_x)
 - ❖ Volatile Organic Compounds (VOC)
 - ❖ Non-Methane Hydrocarbons (NHMC)
 - ❖ Particulate Matter <2.5μm (PM_{2.5})
- ◆ Emissions aggregated for comparison to 2002 National Emissions Inventory [NEI] to measure aircraft's contribution to local air quality

Comparison to the NEI (325 airports)

Percentage of National Emissions Inventory Due to Aircraft by Area

- ◆ 3 areas have more than 10% of at least one of the estimated pollutants attributed to aircraft
- ◆ 2 areas have at least 10% of the areas estimated emissions for three pollutants
- ◆ Targeting initiatives may provide the most benefit where aviation has a stronger influence in local air quality

- ◆ For NO_x , aircraft are the source of less than 1% of the total emissions for at least 77% of these areas
- ◆ For 94% of the total aircraft related PM_{2.5} is responsible for less than 1% total emissions

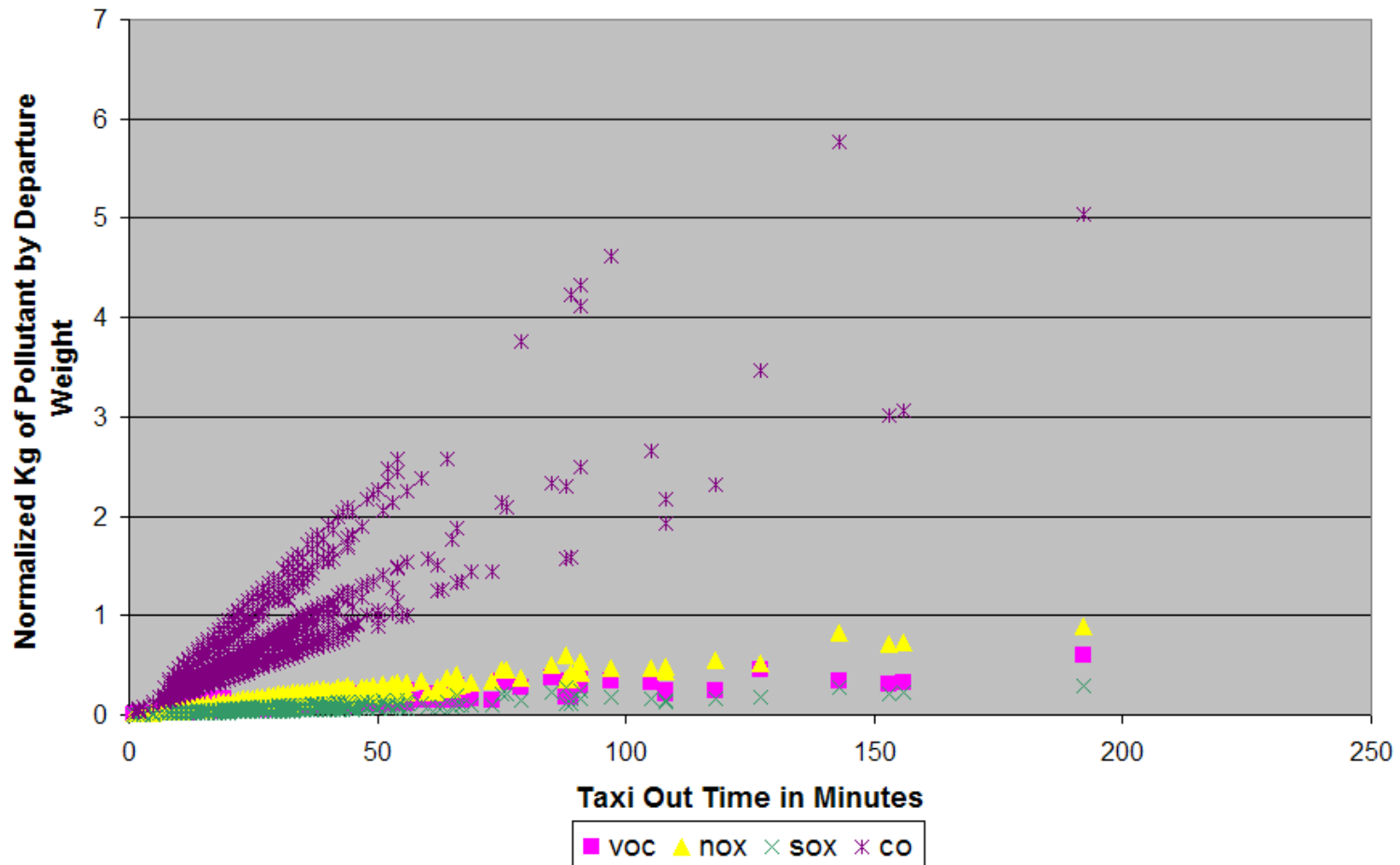
Aircraft Emissions Contribution (%)

Analysis 2: Congestion and Delay

- ◆ Explore the relationship between emissions and time in mode
- ◆ Evaluate the pattern of delay and emissions to help identify appropriate air traffic management initiatives

Emissions and Delay

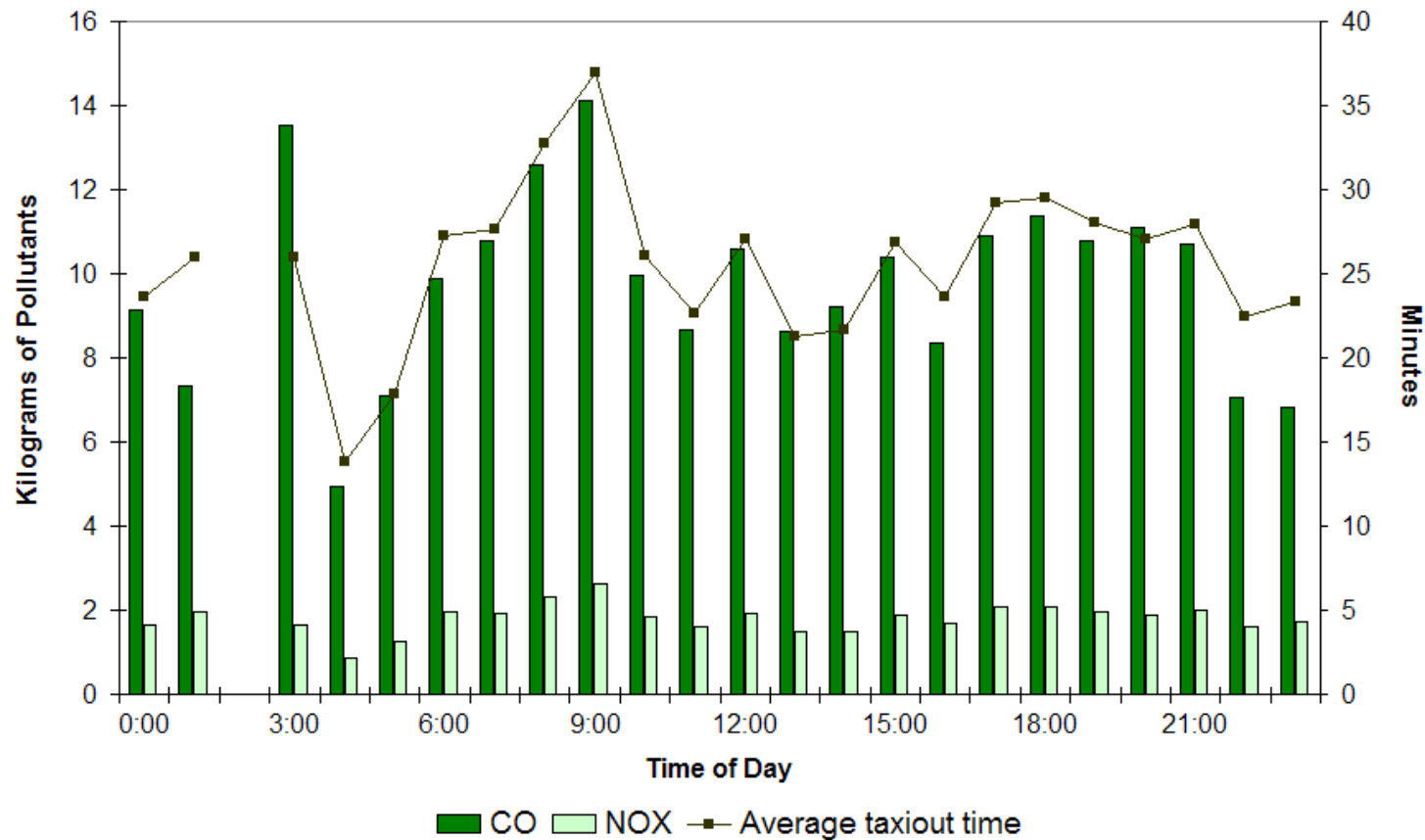
Sample Taxi Out Boeing 737 Series Emissions Normalized by Departure Weight at ATL for November 15th through December 27th, 2005



* Preliminary Results, DO NOT CITE OR QUOTE *

Consistent Delay All Day

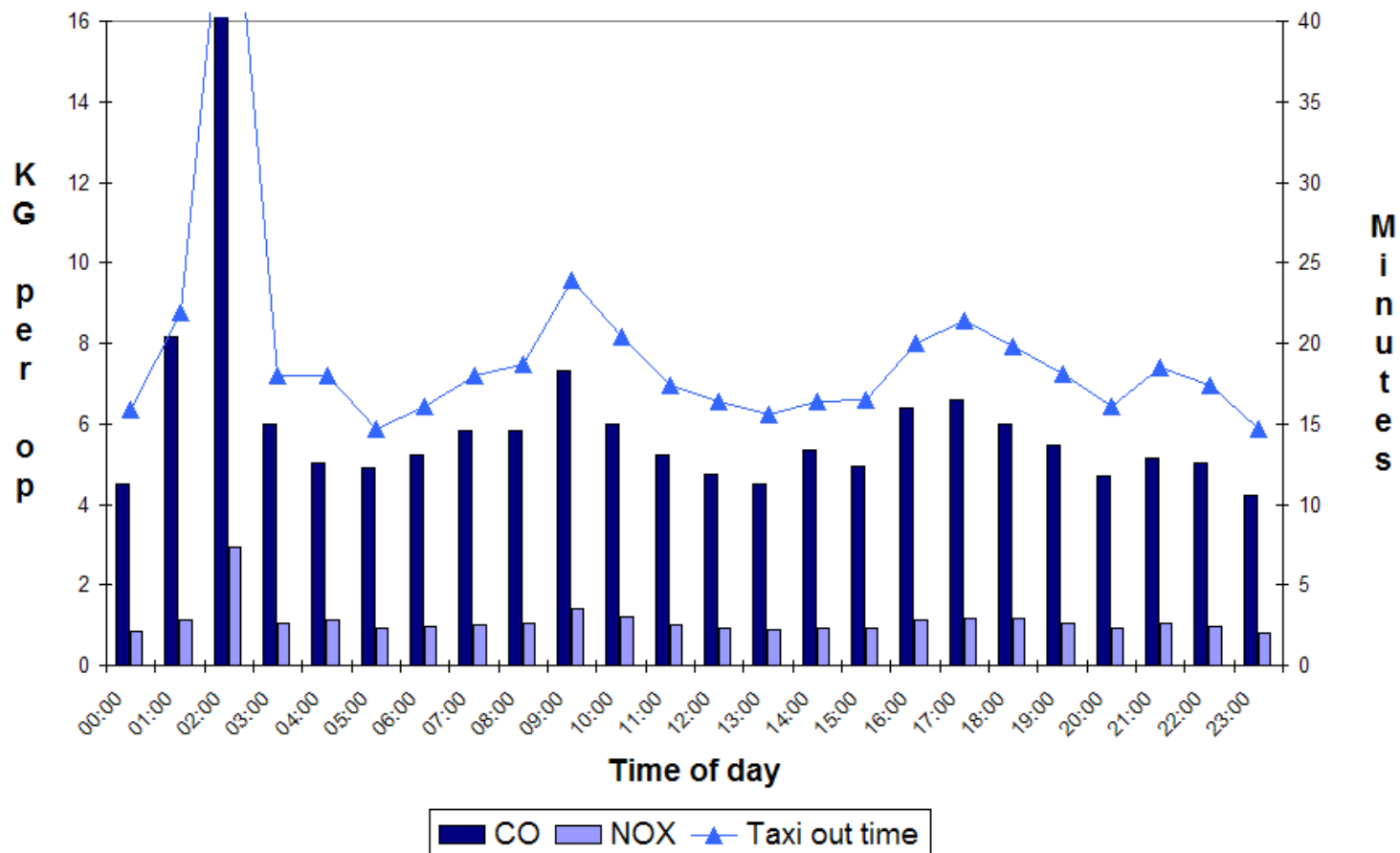
Average Emissions and Taxi Out Time of Boeing 737s at EWR by Time of Day between November 15th and December 27th, 2005



* Preliminary Results, DO NOT CITE OR QUOTE *

Departure Pushes and Delay

Average Emissions and Taxi Out Time of Boeing 737s at ATL by Time of Day between November 15th and December 27th, 2005



* Preliminary Results, DO NOT CITE OR QUOTE *

Analysis 3: Initiatives

- ◆ Quantify the potential benefits from reducing ground delay
- ◆ Identify possible potential initiatives
- ◆ Evaluate sample initiatives as demonstrations

Method for Measuring Potential Benefits of Delay Reduction

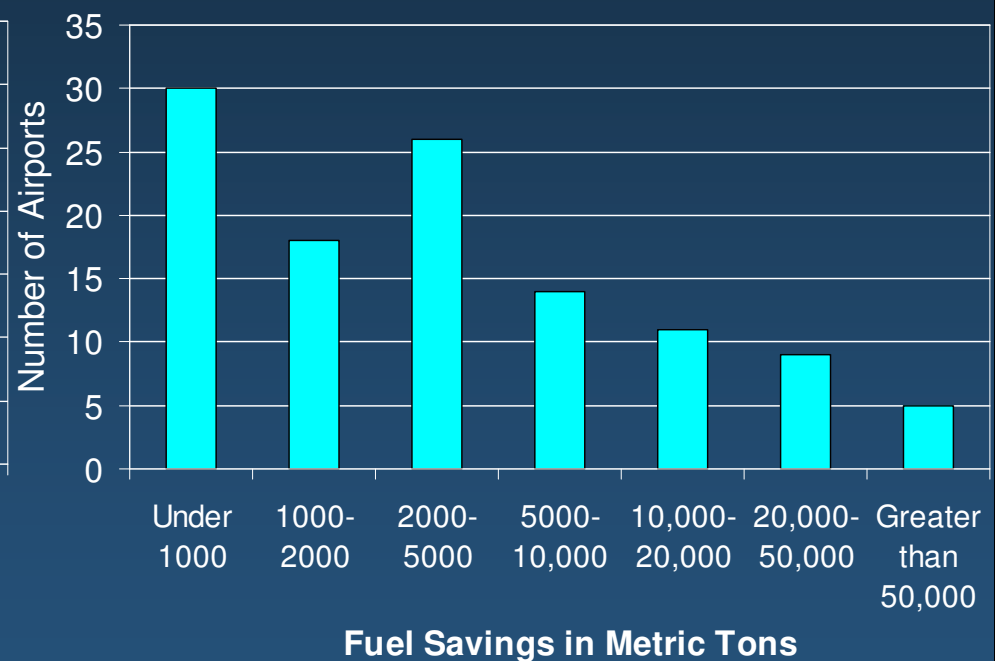
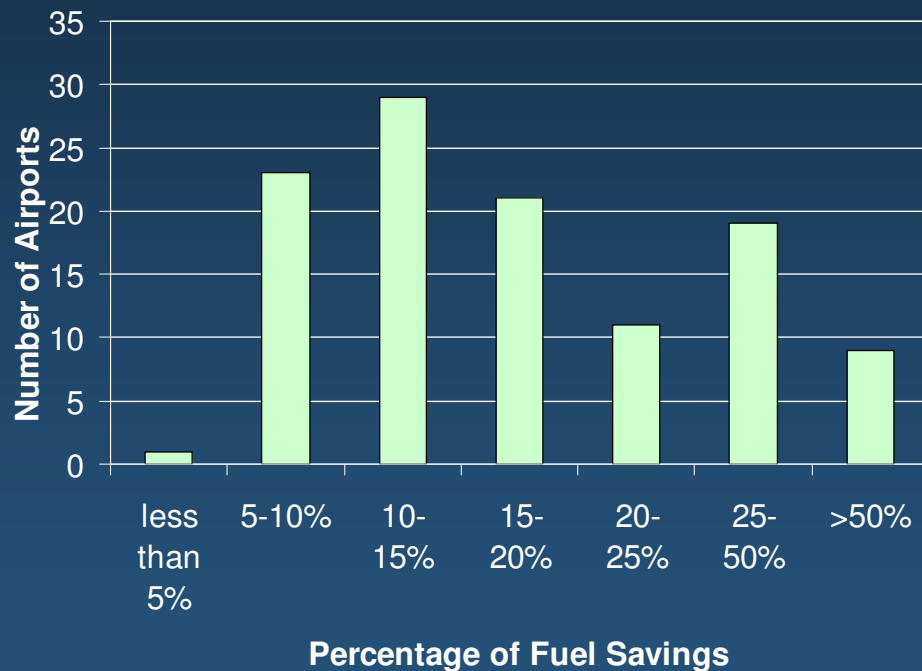
- ◆ Define the scope of emissions associated with delay:
 - ❖ Created unimpeded taxi times
 - ❖ Created a baseline inventory based on unimpeded taxi times
 - ❖ Compared the actual operations to the unimpeded operations to estimate the potential benefits of delay reduction

Airport Selection for Potential Delay Reduction

- ◆ Bureau of Transportation Statistics provides Out – Off – On – In (OOOI) times for certain air carrier flights
- ◆ Where OOOI information was not available, the baseline inventory assumed standard International Civil Aviation Organization (ICAO) taxi times of 26 minutes
- ◆ Only 113 airports in the original selection had OOOI information and were evaluated so that the benefit would be based on actual delay rather than default values

Potential Benefits from Delay Reduction (113 airports)

Fewer operations and less fuel used means a larger % change



However, in large airports with high delay and operations, small changes in percentages can equal large fuel changes in tons

Potential Benefits from Delay Reduction (113 airports)

Pollutant	Mass (metric tons) of Reduction	Percentage of Reduction
Carbon Monoxide (CO)	26702	21%
Non-Methane Hydrocarbons (NHMC)	3809	15%
Volatile Organic Compounds (VOC)	4088	15%
Nitrogen Oxides (NO _x)	4007	6%
Sulfur Oxides (SO _x)	1341	16%
Particulate Matter < 2.5 μm (PM _{2.5})	113	13%

On the ground, aircraft tend to use a low power setting which influences CO emissions more than other pollutants

Initiative Selection

- ◆ Four initiatives are part of the Congressional report
 - ❖ Airspace Flow Program (Boston Logan International Airport demonstrated for this paper)
 - ❖ Continuous Descent Arrivals
 - ❖ Schedule De-peaking
 - ❖ New and Extended Runways

Conclusions

- ◆ Aircraft contribute a small percentage (less than 1%) of emissions to local air quality at current aviation activity levels
- ◆ Aviation could become a more significant proportion of emissions in the future
- ◆ Reducing ground delays can lead to potential reduction of 10-25% in LTO fuel burn and emissions
- ◆ Mitigation of ground / terminal area delays has a positive change on local air quality
 - ❖ aviation initiatives alone are unlikely to resolve poor air quality

Questions?

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