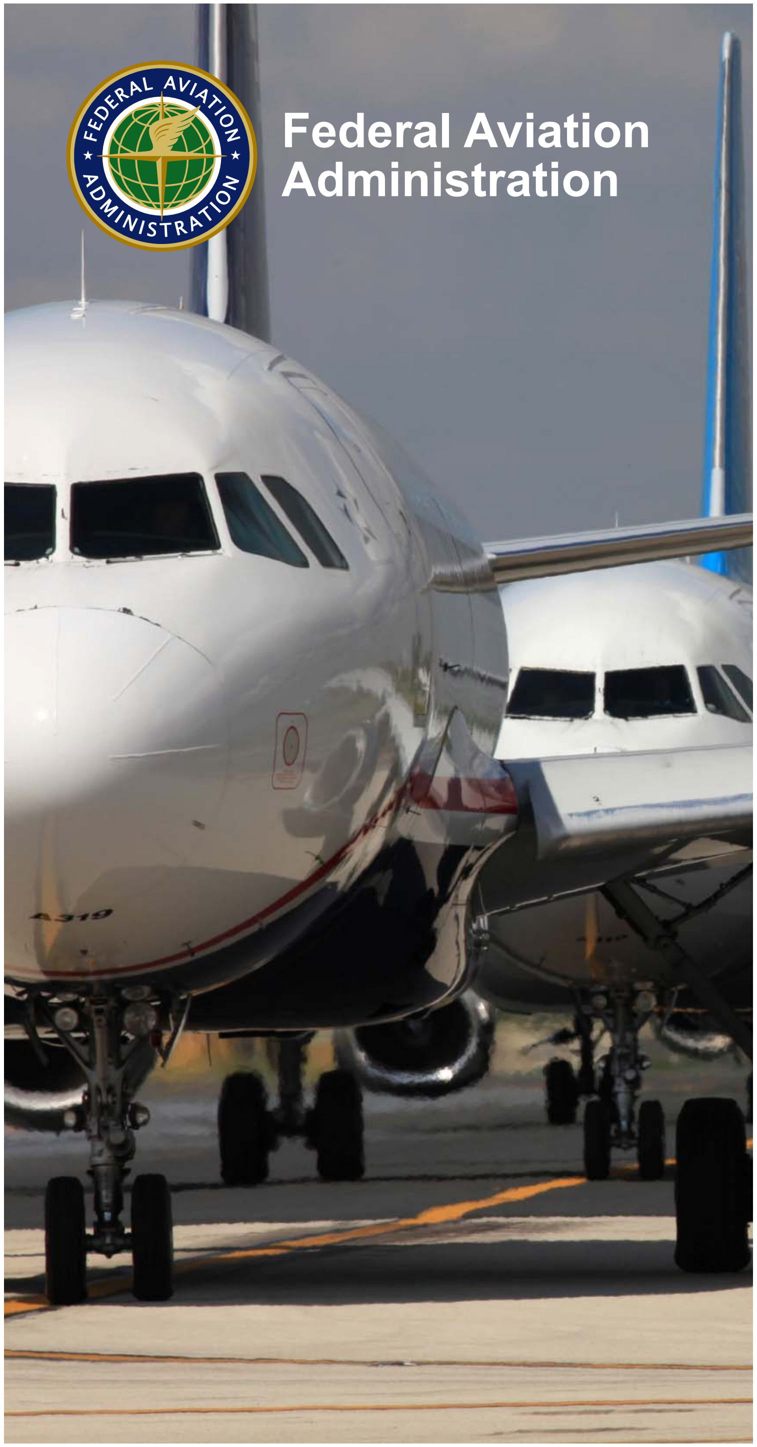
Office of Environment and Energy's (AEE) Air Traffic Management Modernization / Operations Research Program Update



Presented to: **REDAC Environment & Energy Subcommittee**

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Date: 26 March 2014

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FAA's Aviation Environment and Energy (E&E) Goals Establish Performance Metrics for NextGen

Aspect	Aviation Environment and Energy Policy Goals
Noise	Reduce the number of people exposed to significant noise around U.S. airports in absolute terms compared to today, notwithstanding aviation growth, and provide additional measures to protect public health and welfare and our national resources.
Air Quality	Achieve an absolute reduction of significant air quality health and welfare impacts attributable to aviation, notwithstanding aviation growth.
Climate	Limit the impact of aircraft CO_2 emissions on the global climate by achieving carbon neutral growth by 2020 compared to 2005, and net reductions of the climate impact from all aviation emissions over the longer term (by 2050).
Energy	Improve NAS energy efficiency by at least two percent per year, and develop and deploy alternative jet fuels for commercial aviation.

*Note: Although the FAA recognizes water quality as a growing environmental concern, changes to air traffic management and technologies are not likely to impact water quality. Therefore, water quality is not a research priority in this program.

Air Traffic Management Modernizations (ATMM) Offer Important Potential E&E Improvements

AEE E&E ATMM Research Program Goals

1. *Identify and accelerate the implementation of air traffic management concepts that will reduce aviation environmental impacts and/or improve energy efficiency*
2. *Investigate the E&E effects of operational changes implemented by the FAA.*

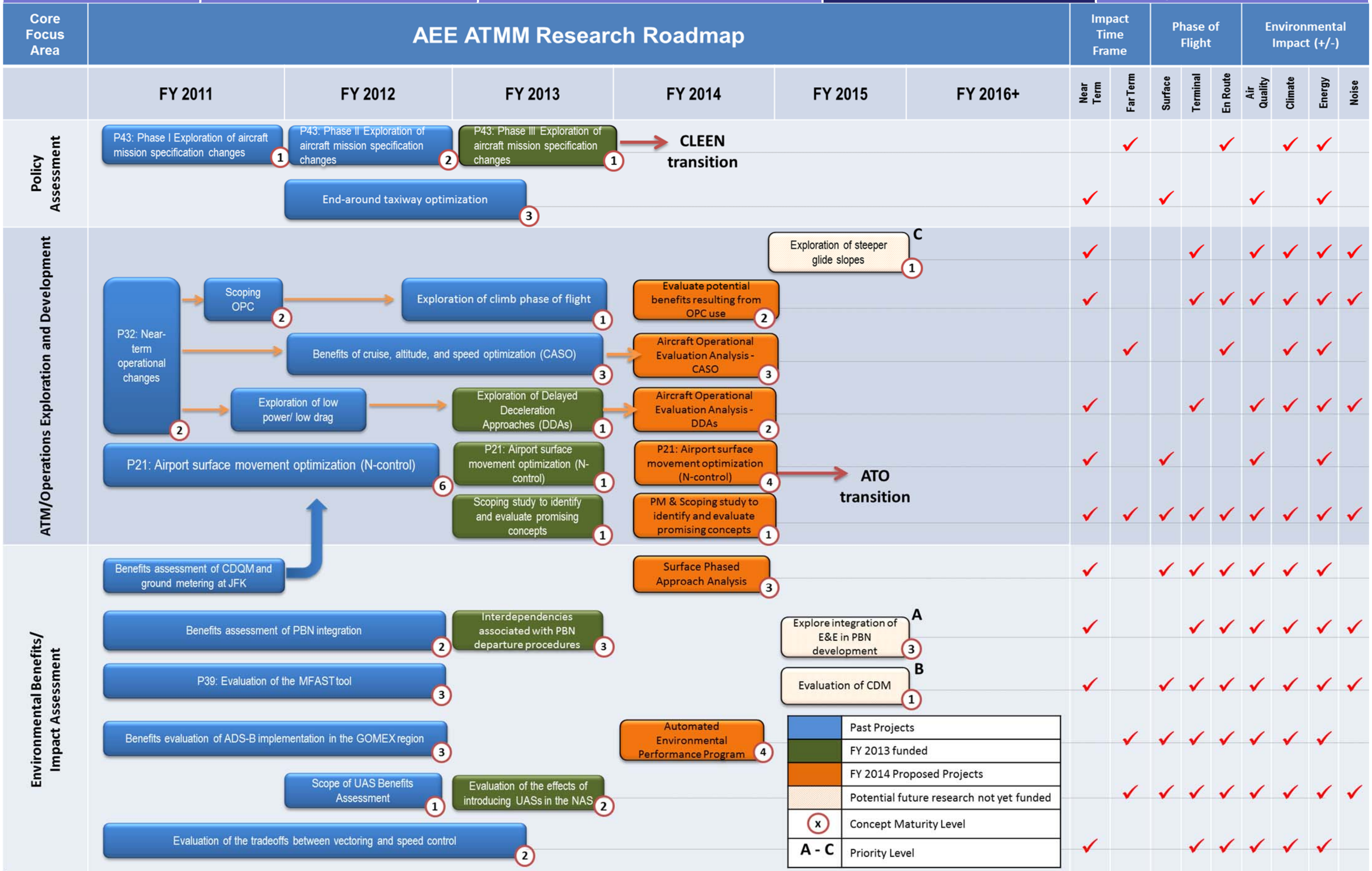
Core Program Elements

- *Research Process: Identifies, conducts, evaluates and transitions ATMM research for implementation*

•Roadmap: Describes areas for ATMM Research near, medium, and long term.
•Portfolio Metrics: Assesses the portfolio's balance with regard to addressing E&E issues and the maturity progression of research project.

AEE's E&E ATMM Research Program has Three Core Focus Areas, Goals and Targeted Outcomes

Alignment	Core Focus	Research Goal	Goal	Planned Outcome
Align with E&E ATMM Research Program Goal 1	**a. E&E ATMM Exploration**	Accelerate ATM Improvements and Efficiencies	Identify, explore, and prove new ATM/Operational concepts with potential E&E benefits or that can accelerate ATM improvements and efficiencies	Improved E&E performance on a per flight basis Transition to the ATO
Align with E&E ATMM Research Program Goal 1	**b. Policy Assessment**	Accelerate ATM Improvements and Efficiencies	Identify and assess existing policy or potential new policies to determine where policy may be changed or new policy developed to accelerate ATM Improvements and efficiencies	Improved E&E performance on a per flight basis Transition to the ATO
Aligns with E&E ATMM Research Program Goal 2	**c. Environmental Impact Assessment**	Determine Impacts (+/-) of NextGen Operational Improvements	Assess the E&E impacts (+/-) associated with implementation of ATM/operational improvements to understand their contribution to aviation E&E goals	Quantitative assessment to inform business case and E&E goals

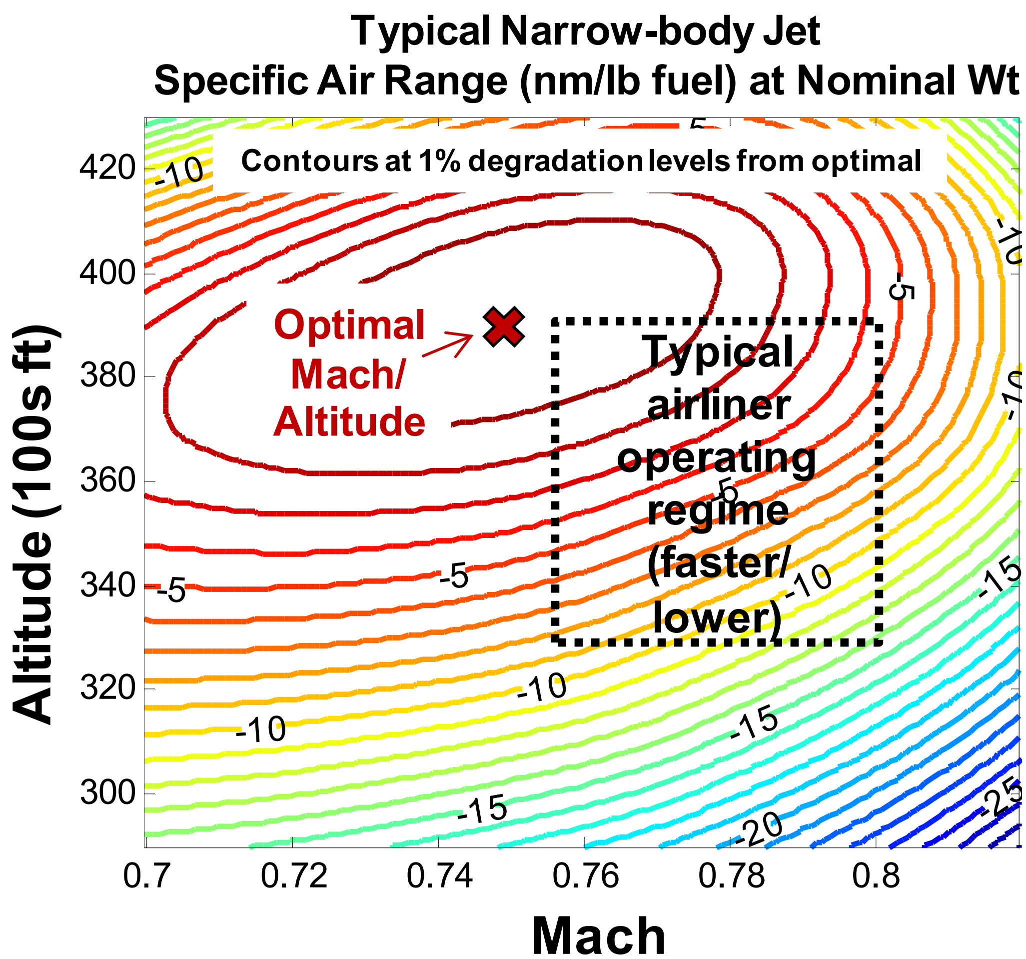

Core Focus Area
AEE ATMM Research Roadmap
Impact Time Frame
Phase of Flight
Environmental Impact (+/-)
FY 2011
FY 2012
FY 2013
FY 2014
FY 2015
FY 2016+
Near Term
Far Term
Surface
Terminal
En Route
Air Quality
Climate
Energy
Noise
Policy Assessment
P43: Phase I Exploration of aircraft mission specification changes 1
P43: Phase II Exploration of aircraft mission specification changes 2
P43: Phase III Exploration of aircraft mission specification changes 1
CLEEN transition
End-around taxiway optimization 3
ATM/Operations Exploration and Development
Exploration of steeper glide slopes 1
C
P32: Near-term operational changes 2
Scoping OPC 2
Exploration of climb phase of flight 1
Evaluate potential benefits resulting from OPC use 2
Benefits of cruise, altitude, and speed optimization (CASO) 3
Aircraft Operational Evaluation Analysis - CASO 3
Exploration of low power/ low drag
Exploration of Delayed Deceleration Approaches (DDAs) 1
Aircraft Operational Evaluation Analysis - DDAs 2
P21: Airport surface movement optimization (N-control) 6
P21: Airport surface movement optimization (N-control) 1
P21: Airport surface movement optimization (N-control) 4
ATO transition
Scoping study to identify and evaluate promising concepts 1
PM & Scoping study to identify and evaluate promising concepts 1
Environmental Benefits/ Impact Assessment
Benefits assessment of CDQM and ground metering at JFK
Surface Phased Approach Analysis 3
Benefits assessment of PBN integration 2
Interdependencies associated with PBN departure procedures 3
Explore integration of E&E in PBN development 3
A
P39: Evaluation of the MFAST tool 3
Evaluation of CDM 1
B
Benefits evaluation of ADS-B implementation in the GOMEX region 3
Automated Environmental Performance Program 4
Scope of UAS Benefits Assessment 1
Evaluation of the effects of introducing UASs in the NAS 2
Evaluation of the tradeoffs between vectoring and speed control 2
Past Projects
FY 2013 funded
FY 2014 Proposed Projects
Potential future research not yet funded
x Concept Maturity Level
A - C Priority Level

AEE sponsors Operations Research for all phases of flight:

- **En Route**
  - Cruise Altitude and Speed Optimization
- **Terminal**
  - Delayed Deceleration Approach
- **Surface**
  - N-Control

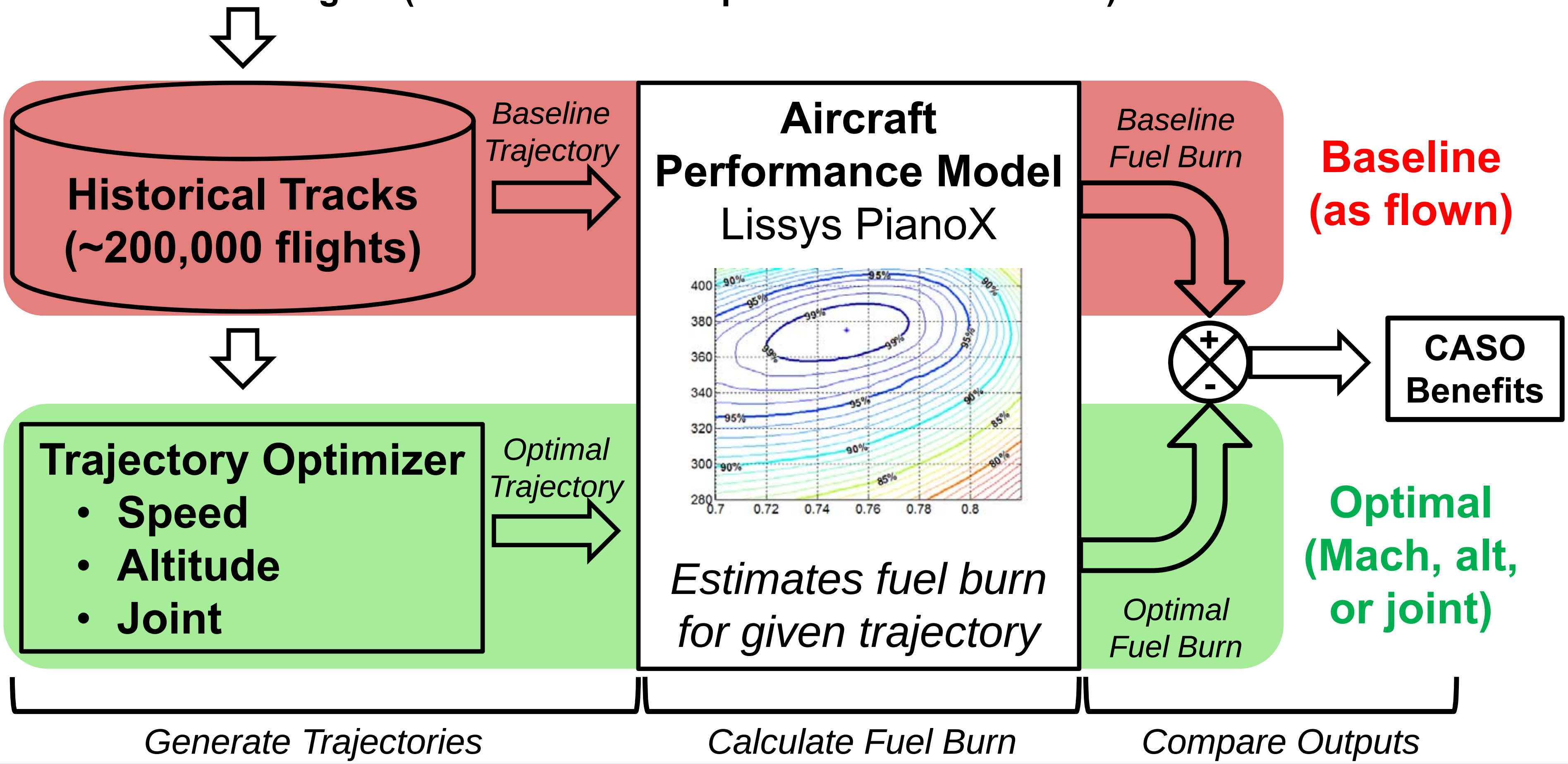
Cruise Altitude and Speed Optimization (CASO)

- **Identifying fuel savings potential from small changes in cruise altitude & speed**
- **Determining opportunities to realize savings in current & NextGen operations**
- **Work with airlines to understand operational & business constraints**

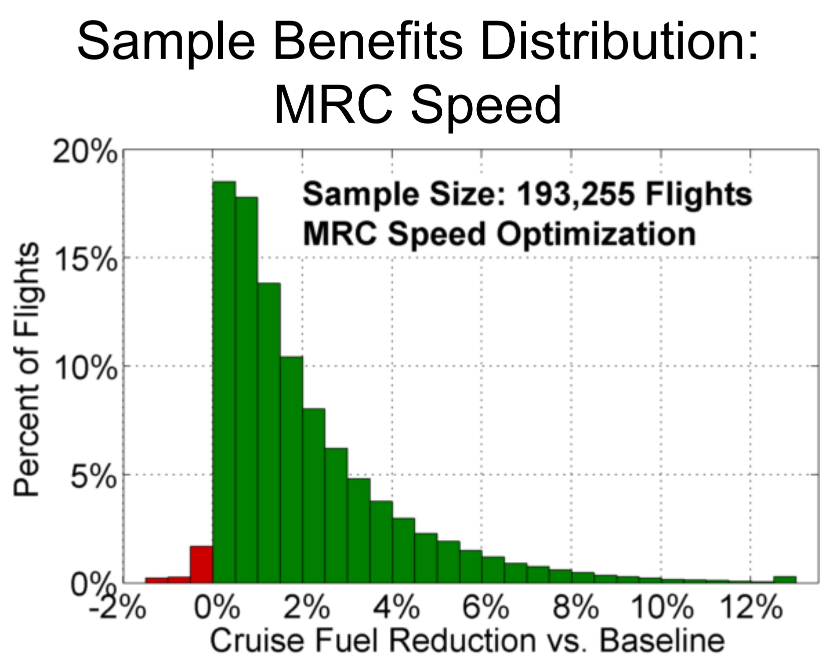


CASO: High-Level Approach

- **Wind and Temperature (NOAA)**
- **Estimated Weights (modeled with sample data from 3 airlines)**



CASO: Sample Speed Optimization Results



- **Two types of speed optimization:**
  - Max Range Cruise (MRC): Fuel-optimal speed
  - Long Range Cruise (LRC): 99% Efficiency Speed
- **Tradeoff between flight time increase and fuel burn reduction**

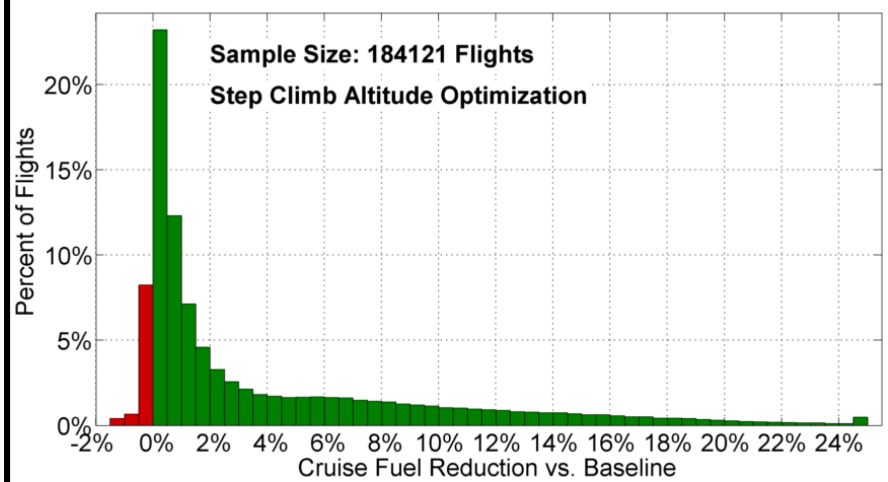
	Mean fuel burn reduction per flight	Mean flight time increase
Maximum Range Cruise ***100% Efficiency***	**105 lbs (1.93%)** std. dev. = 192 lbs	**2.52 mins (3.95%)** std. dev. = 2.85 mins
Long Range Cruise *99% Efficiency*	**50 lbs (0.93%)** std. dev. = 167 lbs	**-0.03 mins (-0.04%)** std. dev. = 2.05 mins

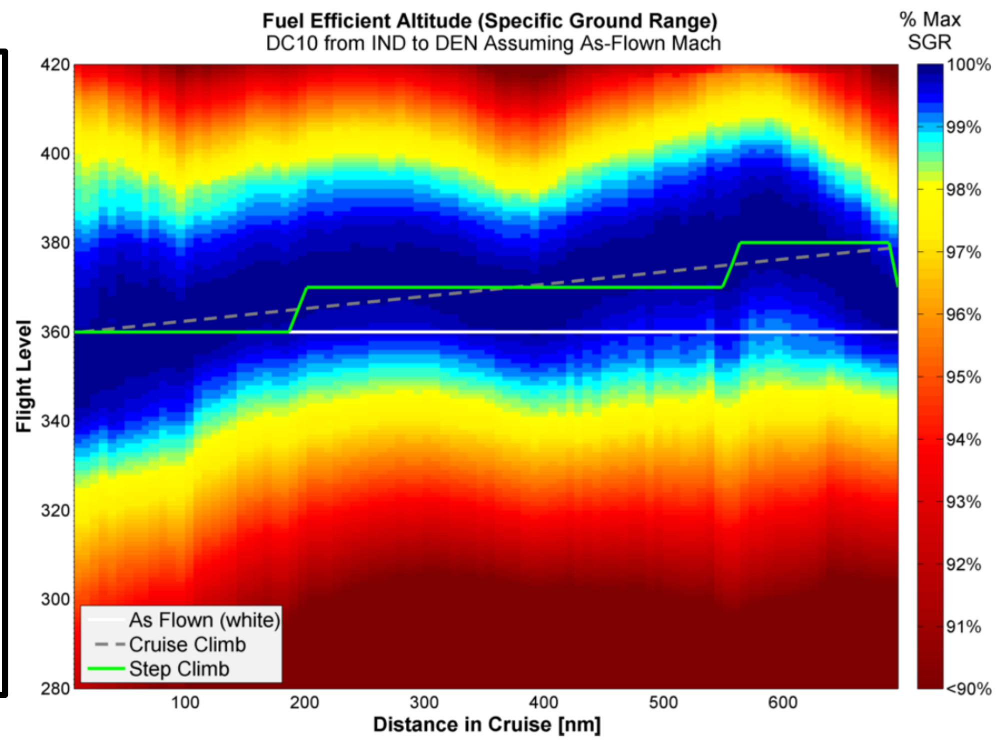
CASO: Sample Altitude Optimization Results

Three types of Altitude Optimization:

Cruise Climb	Step Climb	Flexible VNAV
• Constant rate of climb • Linear regression	• Derived from cruise climb • 1000-ft increments • 2000-ft increments • As-flown baseline	• Allows climbs and descents • Requires 10-minute minimum level flight segments • Captures atmospheric variation

Sample Benefits Distribution:
1000 ft. Step Climb





CASO Planned Next Steps

Extended Analysis

- **Analyze combined altitude/speed optimization**
- **Explore geographic (by region, route, airport, etc.) and operator effects on efficiency**
- **Evaluate applications for oceanic operations**

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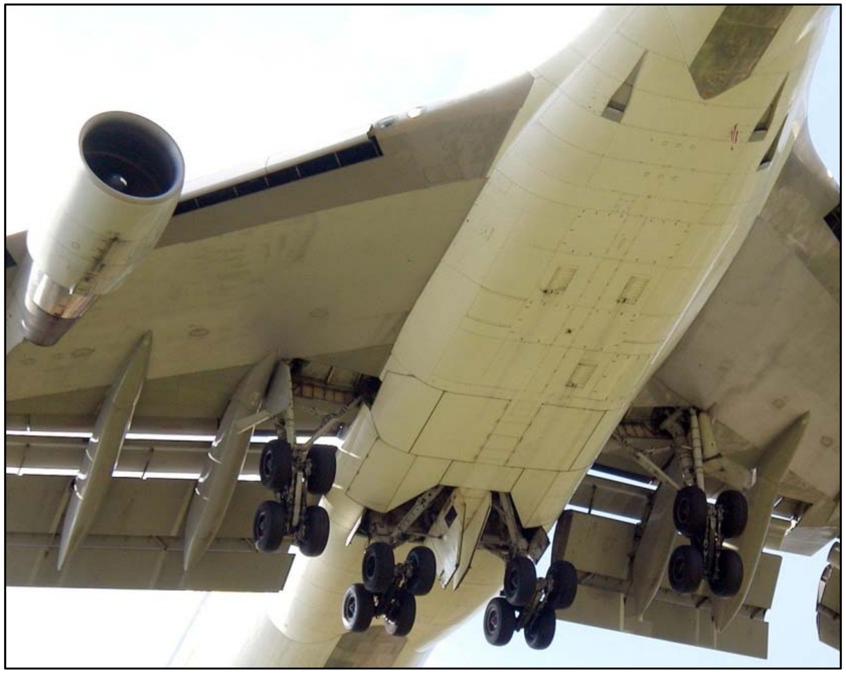
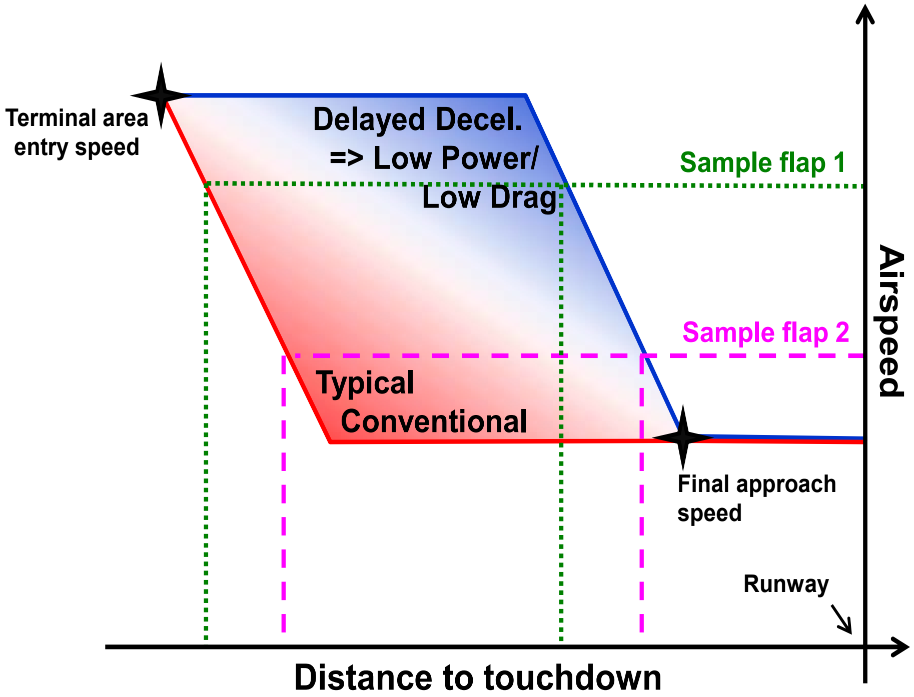
- **Stakeholder results discussions with Operators & Air Traffic**
  - Dissemination & stakeholder interpretations
- **Potentially identify & test modified operating practices**

Knowledge Transfer & Deployment to Operational System

Delayed Deceleration Approach (DDA)

- Reduce fuel burn and emission by maintain higher airspeed with clean aerodynamic configuration for as long as possible during approach without impacting current speed gates

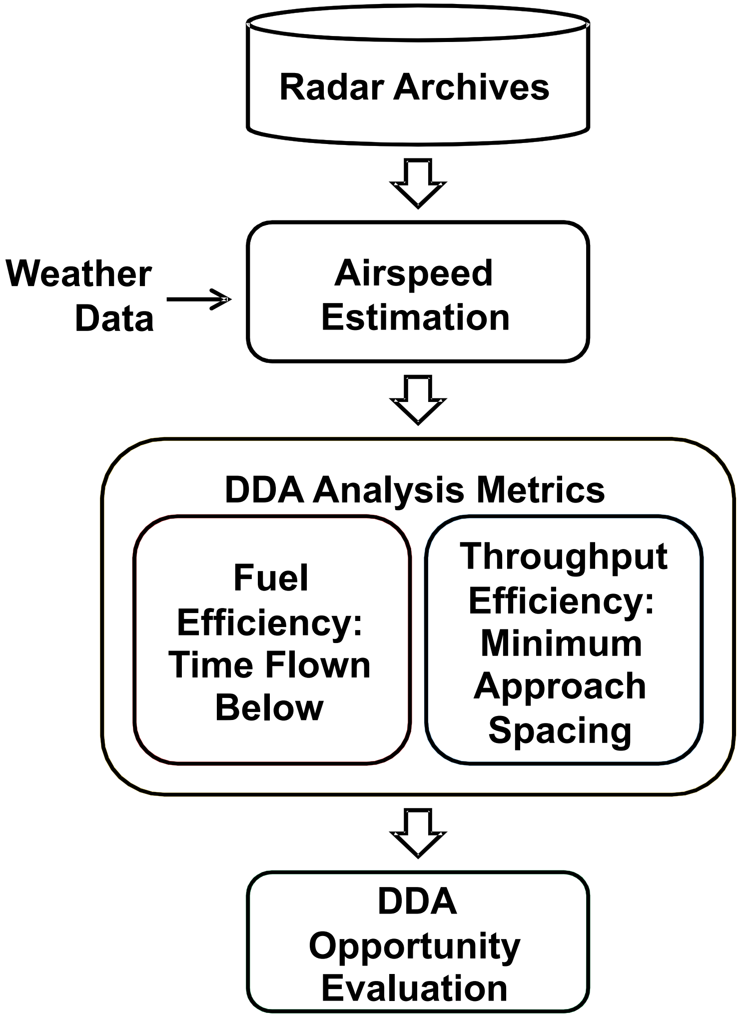




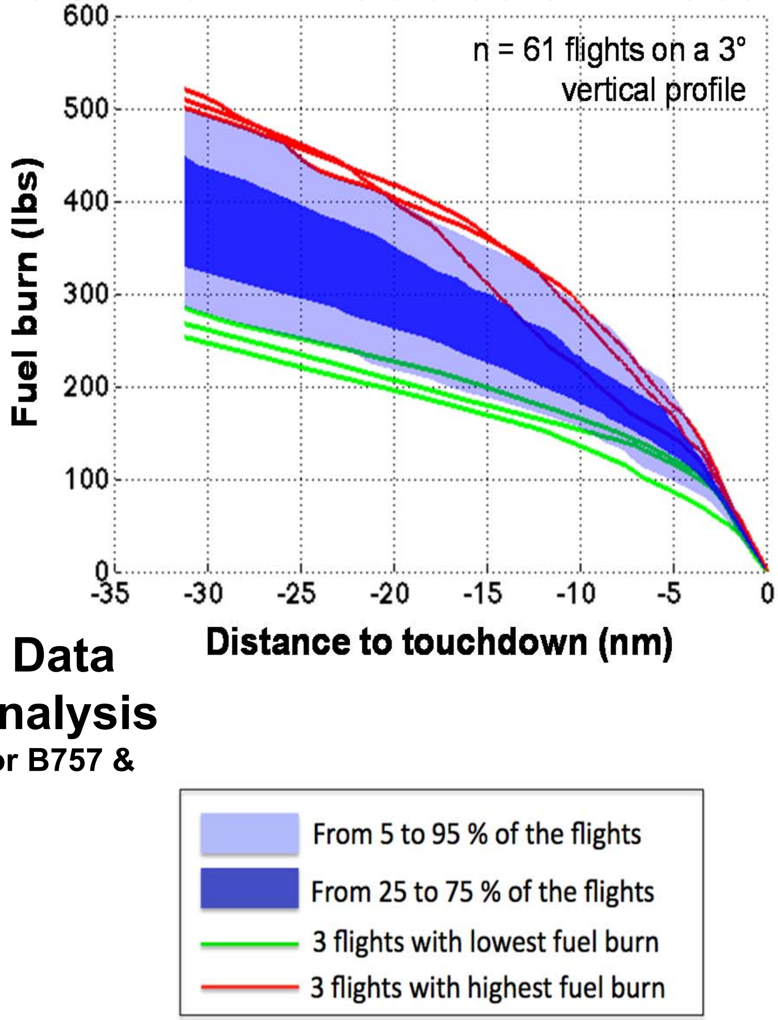
Lower Drag → Lower Thrust → Lower Fuel Burn & Emissions

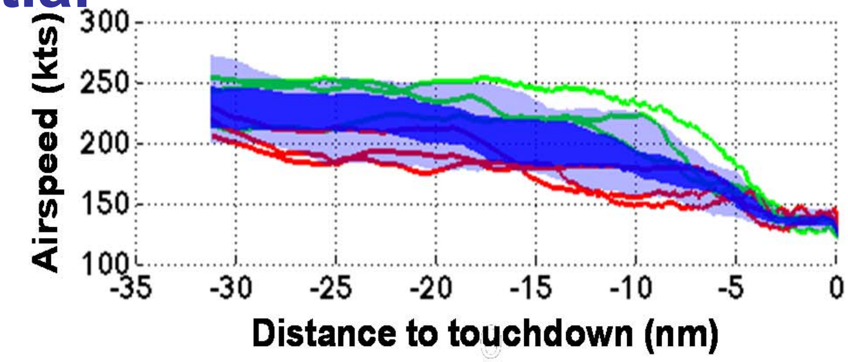
DDA: High Level Approach

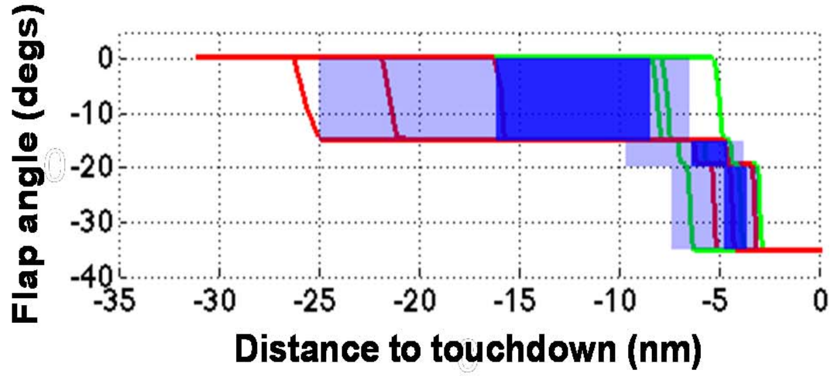
- Establish DDA fuel reduction potential via FDR analysis
- Airport speed profile comparison via radar track analysis
  (**9 months of data: Jan-Sep 2011**)
  - DC Metroplex
  - NY Metroplex
  - Congested Standalone Airports (ATL & LAX)
  - Uncongested Standalone Airports (STL & RIC)
  - Boston
- Detailed analysis of DDA implementation from targeted opportunities

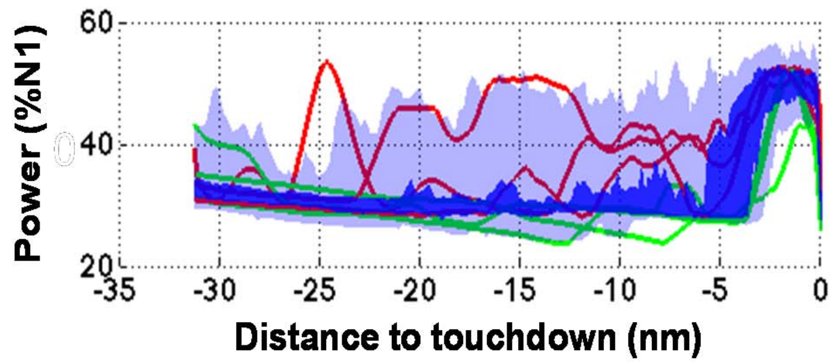


DDA: Fuel Burn Reduction Potential









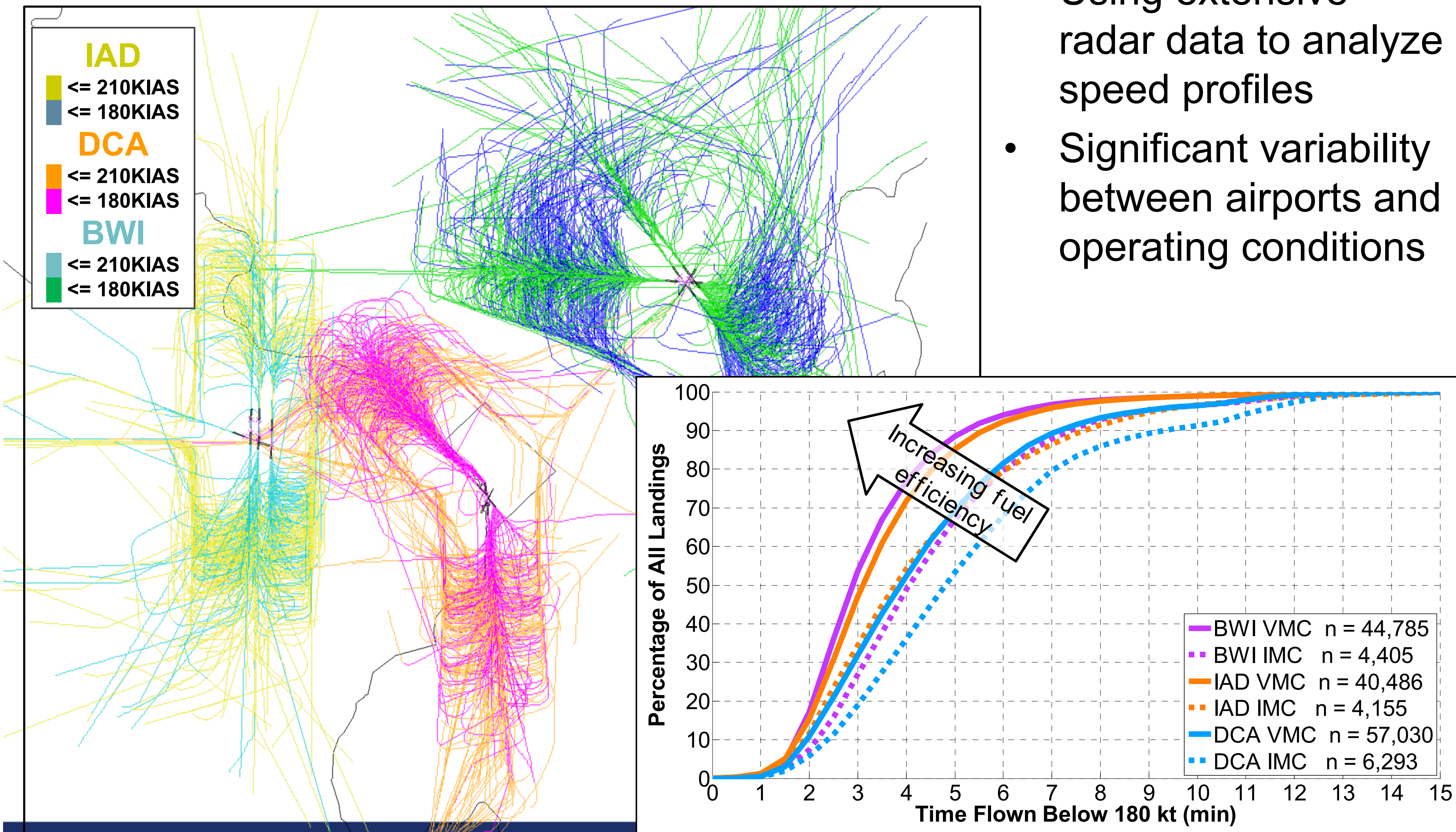
A320 Flight Data Recorder Analysis

(similar results for B757 & B777)

30-50% fuel burn reduction potential from DDAs, 10,000 ft to touchdown

DDA: Sample Airport Track Analysis

- Using extensive radar data to analyze speed profiles
- Significant variability between airports and operating conditions



DDA Planned Next Steps

Extended Analysis

- **Identify opportunities for increased DDA operations**
  - Specific airports, configurations, operating conditions, etc.
- **Analyze noise impacts**
- **Assess controller/pilot impacts of DDAs**
  - Proposing Human-In-The-Loop (HITL) simulations
- **Explore integration of DDA into NextGen concepts**
  - e.g., speed targets in RNAV approaches

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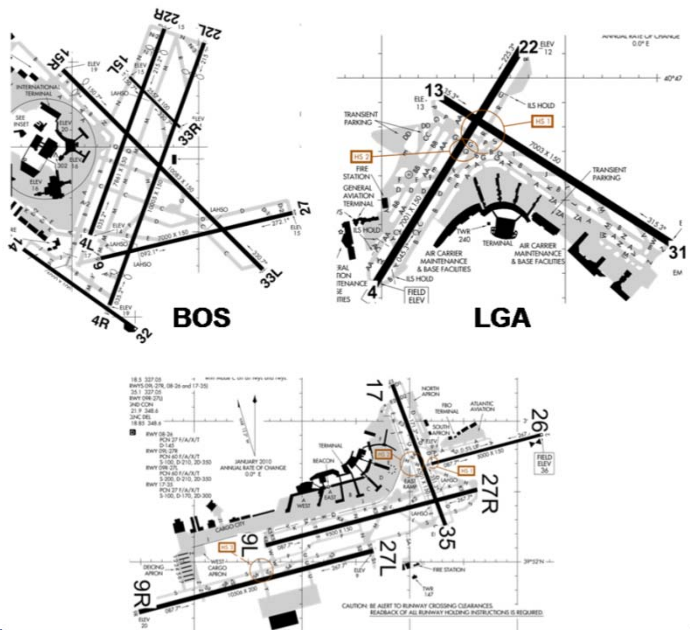
- **Stakeholder results discussions with Operators & Air Traffic**
  - Dissemination & stakeholder interpretations
- **Potentially identify & test modified operating practices**

Knowledge Transfer & Deployment to Operational System

N-Control Overview

- **Surface congestion increases taxi times, fuel burn & emissions**
  - In 2010, over 200 million gallons excess taxi fuel [ASPM]
- **Departure metering holds aircraft with engines off until they can be efficiently handled**
- **Study is developing, analyzing and field testing departure metering approaches suitable for range of airports**
- **Informs FAA decision support programs (e.g., TFDM)**



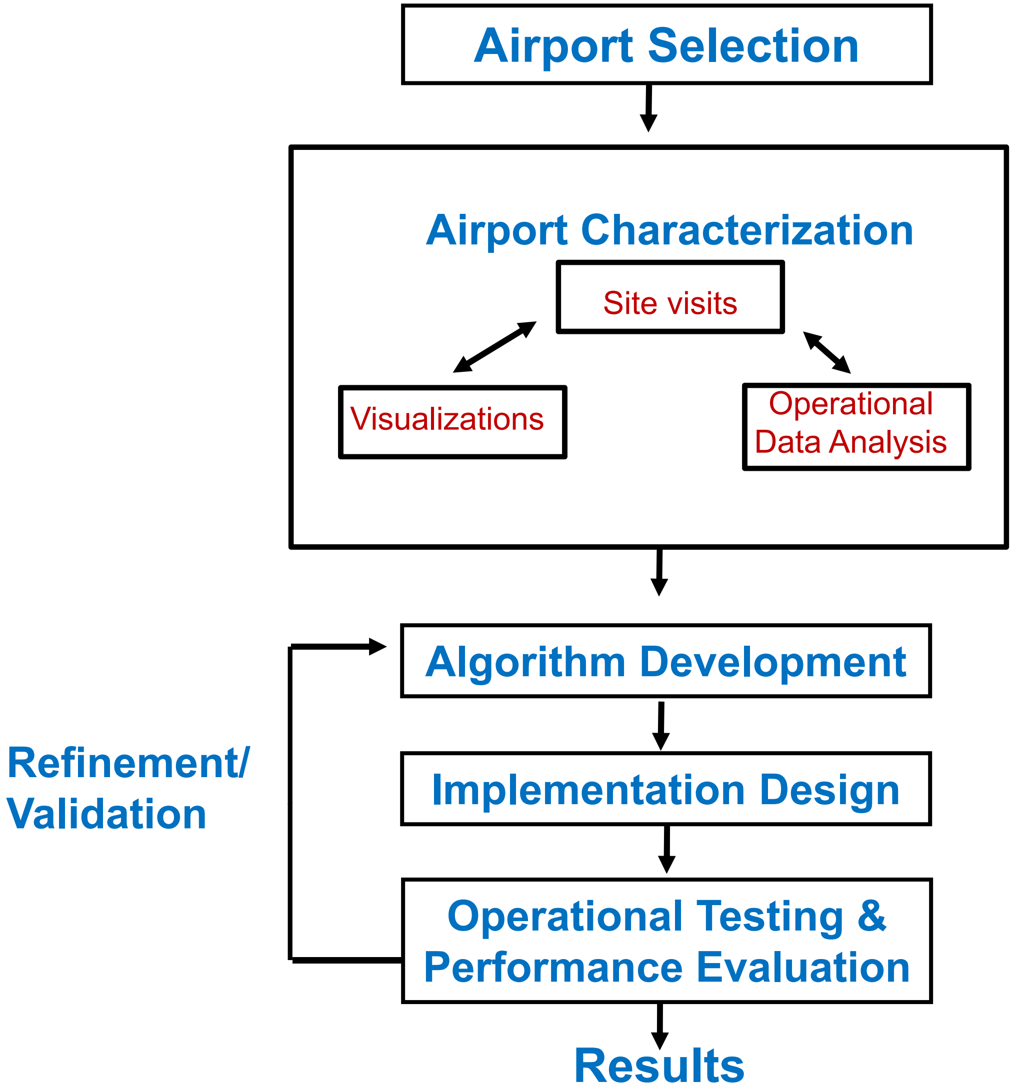
N-Control: High Level Approach

N-control pushback rate approach developed and successfully trialed at BOS during 2010 and 2011

Need to understand adaptation challenges for range of congested airports

- LGA next focus airport

Developed & executed framework for adapting departure metering algorithms to specific airport operations



N-Control: LGA Simulation-Based Testing of Algorithms

- **Simulations of operations in Aug 2012, Jan 2013 and Apr 2013**
- **Integration/validation of unimpeded taxi-out times, VMC/IMC, runway configurations, weather (RAPT values) and gate usage**

Estimated unimpeded taxi-out times

Terminal	August 12	January 13	April 13
T – A	14 min	14 min	14 min
T – B	13 min	13 min	13 min
T – C & D	16 min	15 min	15.4 min

- **Evaluation metrics include**

− Gate holds

− Taxi-out times (and savings)

− Runway throughput

− Preservation of First Come First Served (FCFS) sequence (First push ➡ first takeoff)

Simulation Results:

FCFS is preserved to a greater extent with metering than without

N-Control: Schedule and Status

- **LGA airport selection and categorization: complete**
- **Refined algorithm development: complete**
- **Refined algorithm development: complete**
- **Implementation design: near-complete (final approvals of ATC and airlines pending)**
  - Recent personnel changes in LGA
- **Operational testing and performance evaluation: planned for Spring 2014**

Thank You