Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

Update to the Environmental Working Group

Presented by: Jim McDaniel
Program Manager
James.McDaniel@faa.gov
202-493-4707

November 17, 2008
Meeting Agenda

- AIRE Objectives and Program Organization
- Metrics Results and Plans
- Domain Results and Plans:
  - Oceanic
  - Optimized Profile Descent (OPD)
  - Tailored Arrival (TA)
  - Surface

Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

November 17, 2008
Introduction to AIRE

- **AIRE cooperative agreement signed at Paris Air Show in June 2007**
  - FAA
  - European Commission (EC)
- Hasten development and implementation of environmental improvements for all phases of flight
- Validate improvements with flight trials and demonstrations

Marion C. Blakey
FAA Administrator

Jacques Barrot
EU Vice President & EC Transport Commissioner

*Airline Industry Under Pressure to “Go Green”*
AIRE Objectives

- Hasten development and implementation of operational procedures to reduce aviation’s environmental footprint on a “gate-to-gate” basis
- Quantify environmental benefits to aid in formulation of potential business cases
- Accelerate incorporation and worldwide interoperability of procedures/standards
- Capitalize on existing technology on either side of Atlantic
- Identify implementation issues, obstacles, choke points, metrics and solutions, working with our European partners
NextGen and AIRE

- AIRE is part of NextGen and SESAR efforts
- Environmental constraints to aviation growth are real
- AIRE allows FAA to address near term issues with stepping-stone approach and lay the foundation for the future
- Ultimate goal is innovative solutions that offer environmental protection and system efficiencies
Systematic Program Approach

- **Near Term**
  - Conduct joint interoperability flight trials and demonstrations
  - Demonstrate environmental benefits achievable today

- **Mid Term**
  - Define business case
  - Conduct safety analysis
  - Help with production of standards in unified government/industry process
  - Conduct environmental impact analysis

- **Long Term**
  - Transition modules or segments to implementation
AIRE Domains
Program Management Team

- **Program Manager**
  - Jim McDaniel (ATO-P)

- **Metrics Lead**
  - Sandy Liu (AEE)

- **Surface Lead**
  - Tom Prevost (ATO-P)

- **Oceanic Leads**
  - Thien Ngo (ATO-P)
  - Karen Chiodini (ATO-E)

- **Arrival Leads**
  - TA: Marc Buntin (ATO-P)
  - OPD: Jim Arrighi (ATO-R)
AIRE Accomplishments:

- Jun 07: AIRE Agreement announced at the Paris Air show
- Jun 07: AIRE Brochure and Video presentation developed
- Oct 07: US AIRE Industry Partners meeting at FAA HQ
- Dec 07: FAA FY 08 AIRE Program Plan published
- Mar 08: Joint EC/US Meeting of AIRE in Brussels
- FY 08 demonstrations:
  - May 08: CDAs at Atlanta and Miami
  - May 08: Oceanic enhancements in the Atlantic
  - Sep 08: Tailored arrivals at Miami
- Jun 08: Joint EC/US AIRE PM Working Meeting in DC
- Jul 08: Kickoff Meeting for CDAs for Charleston (CHS)
- Jul 08: SDSS operational at MEM
- Aug 08: Surface ramp surveillance installation at JFK completed
- Sep 08: Report of Demonstration Results
Meeting Agenda

9:00 Start
- Introductions
- AIRE Objectives and Program Organization
- Metrics Results and Plans
- Domain results and Plans:
  - Oceanic
  - Optimized Profile Descent (OPD)
  - Tailored Arrival (TA)
  - Surface
- Questions/Feedback/ Wrap-up
- Lunch
- Demonstrations

3:00 Adjourn
AIRE Metrics
Point of Contact

Project Lead
Sandy Liu
Sandy.Liu@faa.gov
202-493-4864
Metrics

Lead: Sandy Liu

Office of Environment & Energy (AEE)
The AIRE domain demonstrations are proof of concept ATM system enhancements that have been shown to offer major environmental benefits as well as improved operational efficiency.

For each AIRE domain technology/technique, levels of fuel savings / emission and noise reductions will be quantified for the participating trans-Atlantic flights.

Metrics will identify the overall potential for engine emissions and aircraft noise reduction.
## AIRE Environmental Potential
(Reduce fuel burn, emissions & noise)

<table>
<thead>
<tr>
<th>Domain - Demonstration Technology</th>
<th>Operational Metric (source)</th>
<th>Environmental Metric - Fuel Burn, lbs*</th>
<th>Est. Potential Fuel Saving by ATM (Margin of efficiency improvements)</th>
<th>Baseline (rel. ops levels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Taxi time measured</td>
<td>Derived using ICAO Engine Performance Data</td>
<td>2%</td>
<td>MEM historical ops &amp; JFK ops (w/o ASDE-X) Vs Installed ASDE-X</td>
</tr>
<tr>
<td>Oceanic</td>
<td>Fuel burn calc/ measured</td>
<td>As measured by Airline participant(s)</td>
<td>4%</td>
<td>Filed Flight Plan Vs Enhanced Actual Flight Profile</td>
</tr>
<tr>
<td>Arrival</td>
<td>Flight Trajectories measured</td>
<td>Derived by FAA Aviation Environmental Design Tool (AEDT) or ICAO BADA equivalent</td>
<td>2%</td>
<td>Pre CDA/TA Operations Vs Newly developed CDA/TA</td>
</tr>
</tbody>
</table>
Efficiency Mechanisms

**SURFACE (12%)**
- Min APU use or alt clean power
- “just in time” refueling
- Min taxi time & holds (continuous transit)

**DEPARTURE (3%)**
- use of Maximum climb power

**ARRIVAL (25%)**
- Request optimal vertical – CDA/OPD/TA/TAPS
- Delayed flaps

**OCEANIC (60%)**
- use of UPR-User Preferred Routes–updated winds
- Use of DARP - Dynamic Airborne Reroute Procedure - shorten path
- operate at optimum altitude/flt level

Cost Index (economy speed)

Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

November 17, 2008
FY08 AIRE Fuel Savings (current technology)

Domains

- Surface
- Oceanic
- CDA/TA
- Cum

<table>
<thead>
<tr>
<th>Domains</th>
<th>Est. ATC Margin</th>
<th>Wt'd by mechanisms</th>
<th>AIRE</th>
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</thead>
<tbody>
<tr>
<td>Surface</td>
<td>0.30%</td>
<td>0.77%</td>
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<tr>
<td>Oceanic</td>
<td>2.40%</td>
<td>1.5%</td>
<td>0.73%</td>
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<tr>
<td>CDA/TA</td>
<td>0.50%</td>
<td>0.0%</td>
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<tr>
<td>Cum</td>
<td>3.2%</td>
<td>2.5%</td>
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November 17, 2008
ATM Global Environmental Efficiency Goals for 2050
Reducing the Impact of ATM on Climate Change

Aspirational Goals for ATM efficiency improvement

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<tr>
<th>Year</th>
<th>Global ATM efficiency</th>
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<tbody>
<tr>
<td>Baseline</td>
<td>2005</td>
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<tr>
<td>Goal 1</td>
<td>2012</td>
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<td>Goal 2</td>
<td>2020</td>
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<td>Goal 3</td>
<td>2050</td>
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Table 1: CANSO ATM Efficiency Aspirational Goals
IPCC Estimation of Aviation CO2 Influence
## FY08 AIRE Findings & Potential Savings

<table>
<thead>
<tr>
<th>FY2008 Activities</th>
<th>Demonstration</th>
<th>AIRE/ASPIRE Benefits</th>
<th>Cost Saving@$3.08/gal (10/3/08)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oceanic TBO</td>
<td>May Demo- Completed</td>
<td>~ 47 gals/flt</td>
<td>~$145/flt</td>
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<tr>
<td>CDAs @ ATL/ MIA</td>
<td>May Demo- Completed</td>
<td>~38-50 gals/flt</td>
<td>~$150/flt</td>
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<tr>
<td>ASD-X@MEM/JFK</td>
<td>Recently activated</td>
<td>est~ 50 gals/flt</td>
<td>~$150/flt</td>
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<tr>
<td><strong>Current Spain to Caribbean Islands</strong></td>
<td><strong>AIRE Cumulative Total:</strong></td>
<td><strong>Est. 150 gals/flt X 40 flts/wk</strong></td>
<td><strong>$960K/annually</strong></td>
</tr>
</tbody>
</table>
Projected Annual Environmental Benefits
AIRE Current Spain to Caribbean Islands

CO2 Emissions Equivalencies for ASPIRE Demo:
Can potentially save 3K metric tons CO2 = (40 flt ops/wk )
- Annual greenhouse gas emissions from 500 passenger vehicles

Energy:
- CO2 emissions from 312,000 gallons or 6,400 barrels of oil consumed
- CO2 emissions from the electricity use of 365 homes for one year

Off-set Mitigation:
- Carbon sequestered by 70,500 tree seedlings grown for 10 years

Relative to Nature’s Cycle:
- Carbon sequestered annually by 625 acres of pine or fir forests

Conservation:
- CO2 emissions avoided by recycling 1,000 tons of waste instead of sending it to the landfill
FY 09 Metrics Plan

FY09 AIRE Metrics Plan & Strategy - November 08

**Surface:**
- Measure taxi time (# & duration of starts/stops); a/c type (fuel burn rate);
- minimize transient ops

**Oceanic:**
- Apply latest (wind data) Flight Plan; UPR; optimal altitude, speed, settings.

**Arrivals:**
- Explore ATM conditions for optimized profile descent (OPD)/CDAs and
  Oceanic Tailored arrivals (TA)

**Integrated Oceanic/Arrival Metrics Plan January 09**
- Explore initial and smooth bridging of domain systems and
  processes

FY09 Findings and Recommendations September 09
Payload fuel efficiency, PFE, can be estimated from the U.S. DOT Form 41 data according to the following formula:

\[
PFE = \frac{(\text{RevPaxMiles} \times X / 2000 + \text{RTM}_\text{freight} + \text{RTM}_\text{mail})}{\text{fuel} \times LHV},
\]

where:
- \(PFE\) = payload fuel efficiency, in ton-miles per BTU and converted to kg-km/MJ
- \(\text{RevPaxMiles}\) = revenue passenger miles, passenger-miles
- \(\text{RTM}_\text{freight}\) = freight revenue ton miles, ton-miles
- \(\text{RTM}_\text{mail}\) = mail revenue ton miles, ton-miles
- \(\text{fuel}\) = volume of fuel consumed, gallons
- \(LHV\) = fuel volumetric energy content, 124,000 BTU/gal
- \(X\) = weight allotment per passenger

Quantifies:
- productivity (payload moved a given distance) achieved by aviation per unit energy consumed by the aircraft
- profitability
- environmental impacts of commercial aviation.

A change to fuel energy from fuel volume on alternative energy for aviation (independent of future changes in the aviation fuel mix).
Backup Slide follows
### FAA – NextGen Initiatives (from CANSO doc)

<table>
<thead>
<tr>
<th>FAA-NextGen Initiative</th>
<th>Flight phase affected</th>
<th>Selected ATM Implementations</th>
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<tbody>
<tr>
<td>Collaborative Air Traffic Management</td>
<td>Horizontal, Delay, Taxi</td>
<td>Near Term Committed 2012-2018 Mid Term 2020* Far Term 2020*</td>
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<tr>
<td>Airspace Flow Program</td>
<td>Horizontal</td>
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<tr>
<td>Reroute Impact Assessment and Resolution</td>
<td>Taxi and Horizontal</td>
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<tr>
<td>TMF w flight specific trajectories</td>
<td>Horizontal</td>
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<tr>
<td>Improve Special Airspace Management</td>
<td>Horizontal</td>
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<tr>
<td>Trajectory flight data management</td>
<td>All airspace delay/Taxi</td>
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<tr>
<td>Manage Airspace to Flow/Trajectories</td>
<td>Horizontal/Vertical/Taxi</td>
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<tr>
<td>Full Collaborative Decision Making</td>
<td>Taxi and terminal</td>
<td></td>
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<tr>
<td>Initiate Trajectory based Operations</td>
<td>Taxi and terminal</td>
<td></td>
</tr>
<tr>
<td>RNAV/RNP Increased Departure Routes</td>
<td>Delay and vertical</td>
<td></td>
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<tr>
<td>NY and ORD Area Airspace Redesign</td>
<td>Delay/Horizontal</td>
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<tr>
<td>Time Based Metering (moves delay to more fuel efficient altitudes)</td>
<td>Horizontal/Vertical</td>
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<tr>
<td>ADS-B in Gulf of Mexico</td>
<td>Horizontal</td>
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<tr>
<td>Delegated responsibility for Separation</td>
<td>All</td>
<td></td>
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<tr>
<td>Initial Conflict Resolution Advisories</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Point in Space Metering</td>
<td>Horizontal</td>
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<tr>
<td>Increase Capacity and Efficiency Using RNAV and RNP</td>
<td>All</td>
<td></td>
</tr>
<tr>
<td>Expand Conflict Resolution via Data Communication</td>
<td>All in Low Vis</td>
<td></td>
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<tr>
<td>Increase Arrivals and Departures at High Density Airports</td>
<td>Taxi</td>
<td></td>
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<tr>
<td>Improved operations at closely spaced parallel runways</td>
<td>Horizontal/Vertical</td>
<td></td>
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<tr>
<td>Initial Surface Traffic Management</td>
<td>Horizontal/Vertical/Taxi</td>
<td></td>
</tr>
<tr>
<td>Time Based Metering Using RNAV and RNP Route Assignments</td>
<td>Taxi</td>
<td></td>
</tr>
<tr>
<td>Integrated Arrival and Departure Airspace management</td>
<td>Horizontal/Taxi</td>
<td></td>
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<tr>
<td>Optimize Runway Assignments</td>
<td>Taxi</td>
<td></td>
</tr>
<tr>
<td>Use Data Management to Provide Flow and Taxi Assignments</td>
<td>Horizontal</td>
<td></td>
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<tr>
<td>Reduce Horizontal Separation Standard to 3 miles</td>
<td>Taxi</td>
<td></td>
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<tr>
<td>Full Surface Traffic Management with Conformance Monitoring</td>
<td>Horizontal/Vertical</td>
<td></td>
</tr>
<tr>
<td>Use Aircraft Provided Intent Data to Improve Flow and Conflict resolution</td>
<td>Horizontal/Vertical</td>
<td></td>
</tr>
</tbody>
</table>

*Far Term designates initial operating capability prior to 2025
Meeting Agenda

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    - Tailored Arrival (TA)
    - Surface
  - Questions/Feedback/Wrap-up
- Lunch
- Demonstrations

3:00 Adjourn
AIRE Oceanic
Points of Contact

Project Co-Lead
Thien Ngo, ATO-P
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202-267-9447

Project Co-lead
Karen Chiodini, ATO-E
Karen.Chiodini@faa.gov
202-493-5248
AIRE Oceanic / Integration Description & Objectives

- Analyze AIRE demonstration performance and establish baseline to measure fuel consumption and emissions
- Investigate the use of existing oceanic systems and trajectory optimization tools to improve fuel savings and reduce emissions
- Validate new procedures and tools in a controlled environment
- Establish AIRE demonstration activities and partnerships with airlines, industry and other government agencies

Initial AIRE-Oceanic Demonstration

AOC recalculates profile and sends to Oceanic Coordinator. Pilot requests clearance

ATC probes new profile for conflicts

Profile Available: ATC clears aircraft to new profile

Profile Not Available: ATC sends Unable to pilot, investigates alternatives, and suggests alternative profile to AOC

Repeat sequence with Step 2

Sequence repeats at every 10 degrees of longitude
NextGen Oceanic Trajectory Based Operations (TBO) and AIRE Oceanic Vision and Benefit Correlation

- Oceanic Trajectory Management – 4D (OTM4D) will provide more optimal trajectories by
  - finding alternative solutions for oceanic entry, when the preferred choice is not available, and by
  - identifying opportunities to improve trajectories in-flight
- Reduced separation standards for properly equipped aircraft lead to fewer predicted conflicts, and as a result, fewer diversions from the preferred routing
- Oceanic efficiency enhancements and separation reductions result in increased capacity within flow constrained airspace, allowing more aircraft to fly through these areas
Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

November 17, 2008
Initial AIRE-Oceanic Demonstration Partners

Federal Aviation Administration

European Commission

NATS
U.K. National Air Traffic Services

VERACITY
Engineering

IBERIA

CSSI, INC.

BOEING

AirEuropa

American

Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

November 17, 2008
## Air Europa Flight Information for the Initial AIRE-Oceanic Demonstrations

<table>
<thead>
<tr>
<th>Departure</th>
<th>Destination</th>
<th>Test Dates</th>
<th>Flight Number</th>
<th>Datalink Equipage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madrid, Spain (MAD)</td>
<td>Havana, Cuba (HAV)</td>
<td>Mondays (19 &amp; 26)</td>
<td>AEA051</td>
<td>FANS 1/A (Airbus A330)</td>
</tr>
<tr>
<td>Madrid, Spain (MAD)</td>
<td>Santo Domingo, Dominican</td>
<td>Mondays (19 &amp; 26)</td>
<td>AEA089</td>
<td>FANS 1/A (Airbus A330)</td>
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<td></td>
<td>Republic (SDQ)</td>
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<tr>
<td>Madrid, Spain (MAD)</td>
<td>Havana, Cuba (HAV)</td>
<td>Tuesdays (20 &amp; 27)</td>
<td>AEA051</td>
<td>FANS 1/A (Airbus A330)</td>
</tr>
<tr>
<td>Madrid, Spain (MAD)</td>
<td>Caracas, Venezuela (CCS)</td>
<td>Tuesdays (20 &amp; 27)</td>
<td>AEA071</td>
<td>FANS 1/A (Airbus A330)</td>
</tr>
</tbody>
</table>
Fuel Savings from More Direct to Destination Route Change

Picture: Courtesy of Air Europa Airlines

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November 17, 2008
Fuel Savings from Avoiding Strong Headwinds

Picture: Courtesy of Air Europa Airlines
Initial AIRE-Oceanic Demonstration Results

Fuel Savings (kg) in Oceanic Airspace

Demo Flight Number

Manual input error

Unexpected headwind

Atlantic Interoperability Initiative to Reduce Emissions (AIRE)
November 17, 2008
Initial AIRE-Oceanic Demonstration Results

- Total 6,946 lbs of CO2 with 7 flights (up to 1% fuel saved). This equates to:
  - CO2 emissions from 330 gallons (6.8 barrels) of oil consumed
  - CO2 emissions avoided by recycling 1.0 ton of waste instead of sending to landfill
  - Carbon sequestered by 75 trees seedlings grown for 10 years

Demonstration Dates:
May 19, 20, 26, and 27, 2008
Initial AIRE-Oceanic Demonstration Results

- Analysis from Air Europa Airlines showed improvement in fuel savings up to 1% in oceanic airspace
  - Based on eight (8) oceanic flights
  - Applied continual trajectory adjustments during flight using manual procedures
  - Route optimized within New York Center and Nav Portugal controlled airspace only
- Result indicated significant savings according to Air Europa Airlines
Initial AIRE-Oceanic Demonstration Outcomes / Observations

- Demo provided valuable information for the longer term OTM-4D development
- Collaboration provides framework for global harmonization consistent with NextGen and SESAR
- Demo provided estimates of fuel savings for a limited number of flights
- Demo highlighted need for co-ordination among oceanic centers, AOC, ATC, and flight crew
- Demo identified need to expand to include more flights
- Provide valuable insight towards automation systems development
FY09 AIRE-Oceanic/Integrated Demonstrations

- Expand domestic and international partnerships
  - Include more partners (airlines, ATC centers)
- Include both westbound and eastbound flights
- Integrate with other domains to explore gate-to-gate concepts
  - Integrated AIRE Oceanic & Tailored Arrivals (TA) and/or Optimized Profile Descent (OPD) demonstrations
- Identify requirements for early implementations
  - Leverage AIRE-Oceanic demo results and lessons learned
- Expand data collection and analysis
## AIRE Oceanic/Arrivals Integration: Potential Partners

<table>
<thead>
<tr>
<th>Service Providers</th>
<th>Airlines</th>
<th>Airports</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>• NY Center (ZNY)</td>
<td><strong>Oceanic Demo:</strong></td>
<td>• Miami (MIA)</td>
<td>• Boeing</td>
</tr>
<tr>
<td>• Miami Center (ZMA)</td>
<td>• Air Europa</td>
<td>• Paris (CDG)</td>
<td>• CSSI</td>
</tr>
<tr>
<td>• Miami Approach</td>
<td>• Iberia</td>
<td>• Madrid (MAD)</td>
<td>• MITRE</td>
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<td>• WJHTC</td>
<td>• American</td>
<td>• Frankfurt (FRA)</td>
<td>• CAASD</td>
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<tr>
<td>• Nav Portugal</td>
<td>• Air France</td>
<td>• London (LHR)</td>
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<td>• UK NATS</td>
<td>• Lufthansa</td>
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<td>• Eurocontrol</td>
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<td><strong>Integrated Demo:</strong></td>
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<td>• Air France</td>
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<td>• Lufthansa</td>
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### FY09 AIRE–Oceanic/Integration Schedule

<table>
<thead>
<tr>
<th>FY09 Milestones &amp; Deliverables</th>
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<tbody>
<tr>
<td><strong>AIRE-Oceanic ConOps</strong></td>
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<td><strong>Demo Procedures</strong></td>
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<td>- Develop for Oceanic Demo</td>
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<td><strong>Demo SRMDMs</strong></td>
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<td><strong>Demo Metrics Plans</strong></td>
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<td>- Develop Final Report</td>
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Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

November 17, 2008
Meeting Agenda

9:00 Start
- Introductions
- AIRE Objectives and Program Organization
- Metrics Results and Plans
- Domain results and Plans:
  - Oceanic
  - Optimized Profile Descent (OPD)
  - Tailored Arrival (TA)
  - Surface
- Questions/Feedback/Wrap-up
- Lunch
- Demonstrations

3:00 Adjourn
AIRE Optimized Profile Descent (OPD)

Point of Contact

Project Lead
Jim Arrighi, RNAV/RNP
James.Arrighi@faa.gov
202-385-4680
Optimized Profile Descent (OPD) - What Is It?

- **Published procedure**
  - Possibility of vertical and/or speed constraints
- **Provide a more optimized descent profile**
  - Increased opportunity for reduced-power descent
  - Time, Fuel, Emissions Benefits

*Step-down arrivals*
“Descend to 7000, reduce speed to 210 knots”

**OPD**
“Descend Via DIRTY ONE”
FY08 OPD Activities

- **AIRE OPD Coordination**
  - Two OPD procedures were developed at ATL and MIA
  - 21 OPD demonstration flights were conducted

- **Technical Analysis**
  - AIRE CDA/OPD Demonstration Recap
  - Benefit Analysis of AIRE CDA Demonstration Flights
  - AIRE CDA Human-In-The-Loop (HITL) Simulations
  - AIRE CDA Airspace and Airport Impacts
**AIRE OPD Procedure Development**

**DIRTY (OPD) Compared To FLCON (Non-OPD)**

<table>
<thead>
<tr>
<th>DIRTY</th>
<th>Waypoint</th>
<th>FLCON</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JOINN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVERY</td>
<td></td>
<td></td>
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<tr>
<td>≥ 11,000 ft</td>
<td>DIRTY</td>
<td>Typically cross at 13,000</td>
</tr>
<tr>
<td>10,000 ft, 250 KIAS</td>
<td>BYRDS</td>
<td></td>
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<tr>
<td>≥ 8,000 ft</td>
<td>TIGOE</td>
<td>COSE</td>
</tr>
<tr>
<td>7,700 ft, 220 KIAS</td>
<td>ZINTU</td>
<td>---</td>
</tr>
<tr>
<td>7,000 ft, 210 KIAS</td>
<td>YABB A</td>
<td>---</td>
</tr>
</tbody>
</table>

**Notes:**
- Expect to cross at 34,000 ft
- Typically cross at 13,000 ft
- Landing West: Expect radar vectors to final approach course

Atlantic Interoperability Initiative to Reduce Emissions

November 17, 2008
# AIRE OPD Procedure Development

**RUTLG (OPD) Compared To HILEY (Non-OPD)**

### Table

<table>
<thead>
<tr>
<th>RUTLG</th>
<th>Waypoint</th>
<th>HILEY</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUTLG</td>
<td>JORAY</td>
<td>Typically at cruise altitude and given a descent to FL360</td>
</tr>
<tr>
<td>RUTLG</td>
<td>OSOGY</td>
<td>Typically told to cross at FL240</td>
</tr>
<tr>
<td>RUTLG</td>
<td>ENVOY</td>
<td></td>
</tr>
<tr>
<td>RUTLG</td>
<td>YOSSI</td>
<td></td>
</tr>
<tr>
<td>RUTLG</td>
<td>MILSY</td>
<td>Expect 16,000 ft, 250 kts</td>
</tr>
<tr>
<td>RUTLG</td>
<td>BOYUR</td>
<td>Descended to 10,000 ft once in TRACON airspace</td>
</tr>
<tr>
<td>RUTLG</td>
<td>HILEY</td>
<td></td>
</tr>
<tr>
<td>≥ 11,000 ft</td>
<td>RUTLG</td>
<td>Descended to 8000 ft abeam Ft. Lauderdale Airport</td>
</tr>
<tr>
<td>≤ 11,000 ft</td>
<td>KAINS</td>
<td></td>
</tr>
<tr>
<td>≥ 9000 ft, 240 KIAS</td>
<td>CLYON</td>
<td>CimbA</td>
</tr>
<tr>
<td>4800 ft, 210 KIAS</td>
<td>POZER</td>
<td>JESS</td>
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<tr>
<td></td>
<td>SHZA</td>
<td>RUBO</td>
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</tbody>
</table>

**FL** – Flight Level  
**kts** – knots
AIRE CDA/OPD Demonstration Flights - Atlanta

<table>
<thead>
<tr>
<th>Track Color</th>
<th>Altitude (ft MSL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 2,000</td>
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<tr>
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<td>2,000 – 4,000</td>
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<td>4,000 – 6,000</td>
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<td>6,000 – 8,000</td>
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<td>8,000 – 10,000</td>
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<tr>
<td></td>
<td>10,000 – 24,000</td>
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<tr>
<td></td>
<td>&gt; 24,000</td>
</tr>
</tbody>
</table>

DIRTY Operations West Flow 11 Tracks

Econ Descents

Apparent geometric descent at BEBAD
AIRE OPD Demonstration Flights - Miami

RUTLG OPD Operations
West Flow
6 Tracks

RUTLG OPD Operations
East Flow
4 Tracks

West Flow Operations vectored after KAINS

East Flow Operations fly entire RUTLG STAR

Atlantic Interoperability Initiative to Reduce Emissions (AIRE)
November 17, 2008
Atlanta OPD Benefits Analysis Results

<table>
<thead>
<tr>
<th>Metric</th>
<th>Baseline Average Per Flight</th>
<th>Average OPD Difference from Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Burn (gal)</td>
<td>393</td>
<td>-38 (-10%)</td>
</tr>
<tr>
<td>CO₂ emissions (kg)</td>
<td>3780</td>
<td>360 (-10%)</td>
</tr>
<tr>
<td>Time (min)</td>
<td>31.5</td>
<td>0.8 (-3%)</td>
</tr>
</tbody>
</table>

- Estimated fuel burn reductions of 38 gallons per flight
- Estimated CO₂ emissions reductions of 360 kilograms per flight
- Observed time savings of 0.8 minutes per flight
  - Consistent with higher average groundspeeds for CDA flights
Miami OPD Benefits Analysis Results

**East Flow**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Baseline Average</th>
<th>Average CDA Difference from Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Burn (gal)</td>
<td>324</td>
<td>- 52 (-16%)</td>
</tr>
<tr>
<td>CO₂ emissions (kg)</td>
<td>3121</td>
<td>-497 (-16%)</td>
</tr>
<tr>
<td>Time Flown (min)</td>
<td>31.6</td>
<td>+ 2.4 (+8%)</td>
</tr>
</tbody>
</table>

- Estimated fuel burn reduction of 52 gallons per flight
- Estimated CO₂ emissions reductions of 497 kilograms per flight
- Observed flight time increase of 2.4 min/flight
  - Consistent with increased route distance on the RUTLG in the terminal area
- Fuel efficiency gains are most noticeable where baseline flights level off at FL240 and 16000 ft MSL
Human In the Loop Simulations

- **Objective:** Identify issues and possible mitigation strategies associated with conducting CDA during peak traffic operations
  - Identify factors involved in deciding which aircraft could be cleared to the CDA
  - Investigate impact of CDA on surrounding traffic
    - Under what circumstances must the CDA be discontinued?
    - Identify methods for mitigating these impacts
  - Increase understanding of necessary inter-facility communications
- **Operational impacts of CDA identified through HITLs**
  - Crossing traffic
  - Merging traffic
  - Sector point-outs
  - Inter-facility coordination
Conclusions

- **OPD/CDA benefits demonstrated through AIRE demos at ATL and MIA**
  - ATL: Estimated fuel burn reductions of approximately 38 gallons per flight, CO$_2$ reductions of approximately 360 kg per flight
  - MIA: Estimated fuel burn reductions of approximately 48-52 gallons per flight, CO$_2$ reductions of approximately 460-500 kg per flight

- **Operational CDA impacts identified through HITLs at ATL and MIA**
  - Crossing traffic
  - Departure traffic
  - Sector point-outs
  - Inter-facility coordination

- **Airspace and airport impacts of CDA**
  - Sector geometries
  - Traffic flows in sector
  - CDA top-of-descent location
Meeting Agenda

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- Lunch
- Demonstrations

3:00 Adjourn

Atlantic Interoperability Initiative to Reduce Emissions (AIRE)

November 17, 2008
AIRE Tailored Arrival
Points of Contact

Project Lead
Dr. Marc Buntin, ATO-P
Charles.Buntin@faa.gov
202-493-4697
Tailored Arrivals – What are they?

End State Description: “Dynamic STAR”

- **Tailored arrival — Key features:**
  - Continuous (optimized) descent from cruise altitude to touchdown
  - Tailored for traffic, environment, airspace
  - Controller-to-aircraft communication by data link*
  - Definition of flight path in both time and space (*4D Flight Path*)
  - Flight path coordinated through multiple air traffic domains, centers, sectors

- **Benefits:**
  - Emissions and fuel reduction anticipated
  - Noise significantly decreased (near idle descent)
  - Flight duration reduced by several minutes
  - Dramatically reduced VHF voice communication
  - Overall efficiency and predictability of flight path improved

* If the required data link functionality is not present, tailored arrivals can still be achieved by using pre-negotiated set of standard arrival processes pre-stored in FMS.

**NOTE:** TA development is an iterative process – End state objectives are far-term
Objectives for MIA TAs

- Demonstrate and prove Tailored Arrivals concept in East Coast environment
- Employ and refine end-to-end Tailored Arrivals procedures validated in San Francisco:
  - Second location, involving a new oceanic ATC facility (NYC), new domestic facilities (Miami ARTCC, Miami TRACON), two new airlines
  - New complexities
    - Separately located oceanic and en-route ATS facilities
    - Multiple en-route sector hand-offs
- Opportunity to accelerate NextGen/SESAR
- Employ Tailored Arrivals profile design techniques to previous CDA baseline
- Provide additional data source for FAA Cost Benefit Analysis
Current Tailored Arrivals – Phase I

- Pre-planned RNAV routes which are designed for optimal descent for a given aircraft type – Continuous descent is the goal
  - Routes extend from the oceanic boundary (NUCAR) to the runway threshold
- Speed and Altitude constraints are designed for optimal routing through the airspace and to achieve a conflict-free descent
Current Tailored Arrivals

- The clearances extend from the oceanic boundary (waypoint: SUMRS) to the runway threshold (RW 8L or RW 9)
- Clearance is issued via ATOP/Ocean 21 data-link approximately 45 minutes to 1 hour prior to oceanic exit point
- Special procedures (Cross Facility / Sector procedures) are followed allowing for an unambiguous and uninterrupted descent clearance between facilities and sectors
  - TAs are broken off if necessary due to traffic, weather, etc.
  - Aircraft on TAs receive no priority handling
Up-linked Clearance
Miami Summary 22 – 25 Sep 08

- 6 participating flights:
  - AF90 22 Sep: Full TA
  - AA57 22 Sep: Partial TA
  - AF90 24 Sep: Full TA
  - AA57 24 Sep: Partial TA
  - AF90 25 Sep: Partial TA
  - AA57 25 Sep: Full TA
Lateral Flight Profile (Starting Near Waypoint: HILEY)

Global 5000 Noise Monitoring (Preliminary Flight)

Traffic Deviation (AAL 57)

Weather Deviation (AAL 57)
Lateral Flight Profile (Starting Near Waypoint: NUCAR)

Weather Deviation (AAL 57)
AF90 – 22 Sep 08

Flight Level vs. Time

- Flight Level vs. Time graph showing a line plot with time on the x-axis and flight level on the y-axis.
- The flight level decreases linearly with time.
Flight Level vs. Time

Time (4690 - 6690)

Flight Level (0 - 40000)

AA57 – 22 Sep 08Z
AF90 – 23 Sep 08Z (Non-TA flight)
AF90 – 24 Sep 08Z

Flight Level vs. Time

[Graph showing a downward trend in flight level over time]
Flight Level vs. Time

Temporary Level Off (AAL 57)
Flight Level vs. Time

Flight Level

Time

AF90 – 25 Sep 08
AA57 – 25 Sep 08

Flight Level vs. Time

- Flight Level
- Time

Graph showing the relationship between Flight Level and Time.
Phase 1 MIA Tailored Arrivals
Preliminary Results

- 1 Week of testing was successfully conducted in Miami
- 6 Tailored Arrivals (TAs) were flown during the week of September 22
  - 3 TAs were flown by American Airlines Flight 57
  - 3 TAs were flown by Air France Flight 90
- 3 of the 6 Tailored Arrivals were full TAs while the remaining three were partial TAs (broken out of the TA momentarily)
  - 1 was broken off due to temporary level-off as a precaution for traffic. Level-off could have been avoided by a procedural change (coming Phase 2)
  - 1 was broken off due to traffic near MIA
  - 1 was broken off due to weather in the Center airspace
Preliminary Results, Cont’d

- Data analysis is underway – Anticipate significant fuel burn reduction
- FAA Global 5000 – Miami-Dade Airports (Environmental Office): “The plane looked like a beautiful glider flying over-head – We could not hear it at all!”
- Anecdotal comments from the flight crews report: TAs are very promising / they really liked the procedure – made some recommendations for procedural changes
  - Quote from an Air France Crew: “A nice approach! We can already imagine that, in two or three years, when we will be use to the tailored arrivals, this will be very comfortable.”
- Deviations for traffic and weather executed well. All three aircraft rejoined the TA
- During pre-testing and Phase I, problems were found with ATOP in both the uplink and MIA coordination of clearance.
  - Uplink issues resolved
  - Coordination issues remain which has necessitated a hold on Phase I activities to determine resolution and restart date of flight trials
Immediate Actions Underway

- Resolution of ATOP issues to restart TA trials
- Tweak arrivals for Phase 2 based on lessons learned
- Execute Phase 2 with the possibility of adding two Lufthansa flights (including one Airbus aircraft)
- Perform advanced planning for Phase 3
- Compute metrics for current flights and gear up for restart
Thank You!

We would like to extend a special thanks to Air France and American Airlines for their participation in these trials. We would like to extend thanks to the New York Center (ZNY) and the Miami Facilities (ARTCC, TRACON) and Miami-Dade Airports Office.

We’ve only just begun....
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3:00 Adjourn
AIRE Surface
Point of Contact

Project Lead
Tom Prevost, ATO-P
Tom Prevost@faa.gov
202-267-3363
Airport Surface Trajectory-Based Operations (TBO)

Update to EWG

Tom Prevost
Federal Aviation Administration
Air Traffic Organization - Operations Planning
Advanced Technology Development & Prototyping

November 17-18, 2008
Surface Activities

- Surface TBO Acquisition
- JFK Ramp Project

- Surface TBO Field Demo Sites
  - Memphis
  - Orlando

- R&D Activity
  - Taxi Conformance
  - Display of Taxi Instructions on the Flight Deck
Surface TBO Acquisition

- FAA Acquisition Management System (AMS) process
- Segmented project broken down into 5 implementation segments
- Currently in Segment 1 Concept/Requirements Development (CRD) phase
  - Functional Architecture
  - Shortfall Analysis (first draft)
  - ConUse
- Initial Investment Decision in September 2010
JFK Ramp System - Status

- ASDE-X and data distribution began operation in late August
- Ramp surveillance system operational in late September
- Port authority working procurement process for STM systems
- Delta Airlines using STM at JFK ramp tower and ATL ops center
- FAA Command Center acquiring commercial STM for TMU’s at JFK ATCT, NY TRACON, and NY ARTCC
- Data feed to FAA HQ STBO lab pending installation for metrics collection
  - Support for STBO acquisition business case
Memphis Surface TBO Field Demo Site

- Initial Demo System Installed – Operational in July 2008
- Software Upgrades Installed Mid November
- NAS Change Proposal (NCP) Submitted for System Upgrades
  - Scheduled for January 2009
- Working Collaborative Interfaces to FedEx and NWA
  - Initial interface in late January / early February 2009
- Collaborative Departure Queue Management (CDQM) Demonstrations to Begin in Spring 2009
Orlando Surface TBO Field Demo Site

- Initial MCO Site Briefing Conducted on November 13
- Site Survey Scheduled for week of December 1
- Submit NAS Change Proposal (NCP) Package Mid December
  - Expected approval in late February / early March 2009
- Site Preparation – Early March 2009
  - Power, communications, networking, rack installation
- Equipment Installation – Late March 2009
- System / Software Integration & Testing – April 2009
- System Operational – May 2009
Collaborative Departure Queue Management

- Concept Initiated in Memphis Surface Working Group
  - Need to manage excessive departure queues
  - Runway 9/27 to close for construction in March 2009

- Flight operator receives an allocation of slots to enter the airport movement area (AMA)
  - Allocations based on flight operator “fair share” of predicted available departure capacity
  - Allocations broken down into 15 minute blocks
  - Allocations not divulged to other carriers
  - Flight operator manages aircraft priority

- CDQM concept intends to provide early environmental and fuel-burn benefits while preserving air carrier flexibility
R&D Activity

- Taxi Conformance & Cockpit Display of Taxi Clearance
  - Literature search in progress
  - Initial ConOps to be developed – March 2009
  - Conduct simulations at MITRE ATM lab next summer
END