Today EDMS…
Tomorrow AEDT

Transition to the Next Generation

Presented to:  EPA 18th International Emission Inventory Conference
By:  Ralph Iovinelli
Date:  Happy Tax Day 2009
What is the Emissions and Dispersion Modeling System?

- Started in mid-1980s
- Airports are complex systems of emission sources
- One stop shopping for an airport model to:
  - Quantify emissions,
  - Disperse emissions
  - Forecast emissions
- Spatial & Temporal Accuracy
- Transparent
- 100s of airframe & engine combinations
- System Requirements
  - Pentium 4 or 1.3GHz
  - 512 MB memory
  - 2GB Storage
  - CD-ROM drive
  - Mouse or pointing device
  - Microsoft 2000, XP, Vista
• Emission Inventories 1
  – All Aviation Sources
    • Aircraft, Auxiliary Power Units, Ground Support Equipment
  – All Non-Aviation Sources
    • Onroad Mobile Sources, Power Plants, Parking Facilities, Storage Tanks, Training Fires
  – Multiple Airports Simultaneously
  – Hourly Meteorological Data
    • Dynamic corrections for fuel flow and vehicle performance
    • Airport Configurations
• Emission Inventories 2
  – All Pollutants
    • NOx, SOx, CO, PM2.5, PM10, HC, NMHC, VOC, TOG
    • CO2 (aircraft only)
    • Speciated Organic Gases, including known Toxics
      – New! EPA/FAA SPECIATE profile 5565 for aircraft equipped
        with turbofan, turbojet, and turboprop engines
Data Sources
- ICAO Databank and manufacturer’s reports
- NONROAD
- AP-42 and other relevant USEPA documents

Models
- PM First-Order Approximation (FOA)
- PART5, MOBILE6.2
- SAE Aerospace Information Reports

User Input Requirements
- Aircraft fleet ops, taxi/queue times, perf. params., etc…
- Traffic levels, parking lot throughput
- Stationary Source operations
• Dispersion Analyses
  – User Input Airport Layout
    • Gates, Taxiways, Queues, Runways, etc…
  – AERMOD
  – AERMET
  – AERMAP
# Leveraging Our Current Legacy Systems

<table>
<thead>
<tr>
<th>Tools</th>
<th>Environmental Consequence</th>
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</thead>
<tbody>
<tr>
<td><strong>Emissions Dispersion Modeling System</strong></td>
<td>Individual Airport Emissions Inventories / Concentrations</td>
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<tr>
<td><strong>Integrated Noise Model</strong></td>
<td>Individual Airport Noise Contours</td>
</tr>
<tr>
<td><strong>Noise Integrated Routing System</strong></td>
<td>Regional Noise Impacts from changes to Airports + Airspace<em><strong>ATO Tool</strong></em></td>
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<tr>
<td><strong>MAGENTA</strong></td>
<td><em>Model for Assessing Global Exposure to Noise from Transport Airplanes</em></td>
</tr>
<tr>
<td><strong>System for Assessing Aviation Global Emissions</strong></td>
<td>Global Emissions Inventories</td>
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</tbody>
</table>
• What is AEDT?
• Why AEDT?
• Compatibility w/ EPA Tools
• Policy Implications
• Building Confidence in the use of our Tools
• AEDT Master Planning
What is AEDT?
AEDT Overview

Aircraft Data
Aircraft Fleet Database
Study-Specific Database
Airports Database
Graphical User Interface or Advanced Input Files
Movements Database
Non-aircraft Sources Database

Weather Calculations
Terrain Calculations

Calculate Pollutant Concentrations
Total Noise & Emissions Results Database
Calculate Additional Noise Metrics
GIS Capability

Outputs

Fuel Burn & Emissions Inventories
Noise & Pollutants Grids
Noise Change Analyses
Contours

Aviation Environmental Design Tool (AEDT) Overview
April 15, 2009
New! 4-D modeling of aircraft
- Critical for NextGen and JPDO activities

New! Input multiple radar data formats

New! Input trajectories from NextGen Simulation Models
  • ACES, SIMMOD, TAAMS, RAMS, TARGETS

New! Validated with Flight Data Recorder data

New! Employs Boeing aircraft performance model

New! Confidence in AEDT results by conducting a uncertainty assessment

Public release of AEDT 2.0 planned in Dec 2011
- The official aviation environmental compliance & policy tool for the U.S.
Why AEDT?
Informed Decision?

Noise abatement departure = quieter at monitors

19% more fuel
2% more NOx
82% more HC
85% more CO
Increased engine bypass ratio
- Reduced **Fuel Burn / CO₂**
- Reduced **Noise**
- Increased **NOₓ**

Improved aerodynamic efficiency and reduced weight
- Reduced **CO₂**
- Reduced **Noise**
- Reduced **NOₓ**

Nacelle Modifications
- Reduced **Noise**
- Increased **Fuel Burn/CO₂**

Continuous Descent Approach
- Reduced **Noise**
- Reduced **Fuel Burn/CO₂**

Increased Engine Pressure Ratio & Temperatures
- Reduced **Fuel Burn / CO₂**
- Reduced **HC** and **CO**
- Increased **NOₓ**

The Challenge: Trade-offs in Potential Solutions
Why AEDT?

• Noise & emissions tradeoffs dominate when analyzing aviation environmental effects
  – Local, Regional, Global

• Stovepiped legacy tools
  – Different/conflicting datasets & algorithms to analyze the same system

• It’s all about “making the informed decision.”
• Critical Need:
  – Match simulation accuracy with environmental consequence fidelity

High Density scenarios
Compatibility with EPA Tools
## AEDT and MOVES Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>AEDT</th>
<th>MOVES</th>
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</thead>
<tbody>
<tr>
<td>SQL Relational Databases</td>
<td>YES!</td>
<td>YES!</td>
</tr>
<tr>
<td>Dual Core Processors</td>
<td>YES!</td>
<td>YES!</td>
</tr>
<tr>
<td>1 GB RAM Memory</td>
<td>YES!</td>
<td>YES!</td>
</tr>
<tr>
<td>40 GB Storage</td>
<td>YES!</td>
<td>YES!</td>
</tr>
<tr>
<td>Windows Operating System</td>
<td>YES!</td>
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</tbody>
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Potential Linkages with MOVES

MOVES
- onroad vehicle sources

AEDT
- cars, trucks, buses, motorcycles emissions on airport

Phase 1

MOVES
- onroad vehicle sources
- nonroad vehicle sources

AEDT
- Onroad + ground support equipment and construction emissions on airport

Phase 2

MOVES
- onroad vehicle sources
- nonroad vehicle sources
- aircraft emissions

AEDT
- Onroad + ground support equipment and construction emissions on airport

Phase 1 & 2

Phase 3
Policy Implications
Policy Implications

• **Domestic Regulations**
  – Noise Part 150, Part 161 compliance leads to more fuel burn and emissions?
  – Clean Air Act compliance leads to more noise exposure?

• **NEPA**
  – Which is more important to determine a preferred alternative -- noise or emissions?

• **CAEP**
  – Which makes more sense… Noise or Emissions stringencies?
Building Confidence in the use of our Tools
Assessment

• Objectives
  – Provide sensitivity analyses of output response to uncertainties in input parameters and assumptions.
  – Identify gaps in functionality
    • Identify high-priority areas for further development
  – Contribute to the development of external understanding of AEDT.
  – Establish procedures for future assessment efforts.

• Scope
  – Parametric sensitivity and uncertainty analyses
  – Comparisons to gold standard data
  – Expert reviews (CAEP, TRB, Design Review Group)
  – Capability demonstrations/sample problems
Formal Parametric Sensitivity and Uncertainty Analysis – Sensitivity Analyses

- **Analyses Types**
  - Monte Carlo Simulations
    - Random sample is drawn and run through module, resulting in an output
    - Cycle is performed hundreds to thousands of time, resulting in a set of outputs, which can be used to estimate means, variances, etc
  - Distributional Sensitivity Analysis (DSA)
    - For a single factor, distribution is altered (shift mean, increase standard deviation, change distribution type, etc) while all other factor distributions are held constant.
    - Determine sensitivity of the output response to an individual factor
  - Global Sensitivity Analysis (GSA)
    - Determines how factors contribute to output uncertainty
    - Calculates an averaged global contribution to output variance for each factor (including interaction between factors)
  - Local Sensitivity Analysis (LSA)
    - Provides sensitivity of output response to inputs and assumptions to support decision-making
    - Goal is to understand the behavior of module outputs in the local region of some point of interest
AEDT Master Planning
AEDT Development Team
AEDT2.0 Development Timeline

2007

2008 DRG #2

2009 DRG #3

Interface with ACES & SIMMOD

2010 DRG #4

Interface with TARGETS

2011

Interface with NASPAC, TAAMS, RAAMS

2012

AEDT2.0 public release

Design Review Group meetings 1-2 times per year, as needed

Aviation Environmental Design Tool (AEDT) Overview
April 15, 2009

Federal Aviation Administration
Thank You!