Today EDMS…
Tomorrow AEDT

Transition to the Next Generation

Presented to: EPA 18th International Emission Inventory Conference

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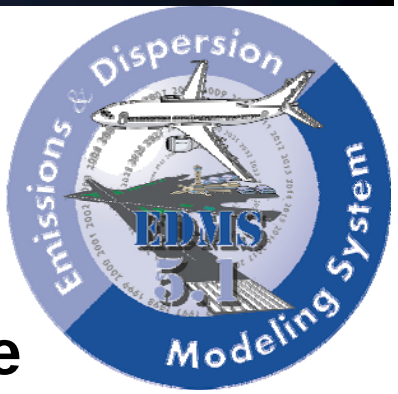
Date: Happy Tax Day 2009

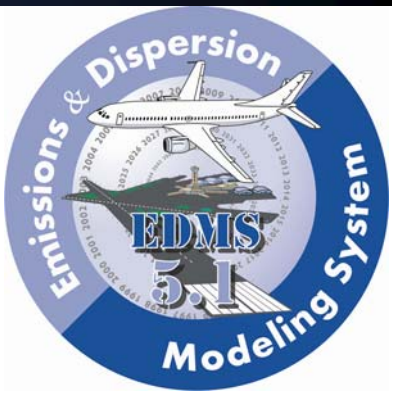
Federal Aviation Administration

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

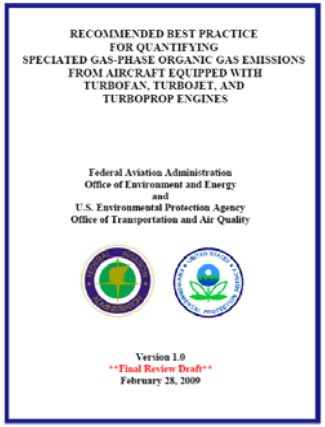
Emissions and Dispersion Modeling System v5.1



- **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

Emissions and Dispersion Modeling System v5.1

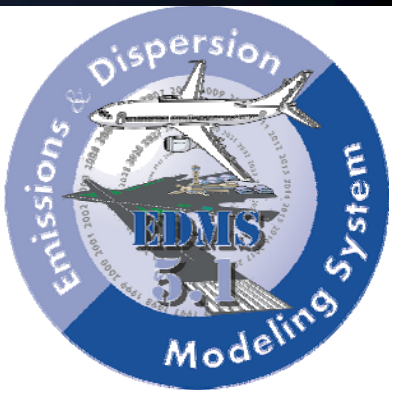
- **Emission Inventories 2**
  - All Pollutants
    - NOx, SOx, CO, PM2.5, PM10, HC, NMHC, VOC, TOG
    - CO2 (aircraft only)
    - Speciated Organic Gases, including known Toxics
      - ***New!*** EPA/FAA SPECIATE profile 5565 for aircraft equipped with turbofan, turbojet, and turboprop engines


RECOMMENDED BEST PRACTICE
FOR QUANTIFYING
SPECIATED GAS-PHASE ORGANIC GAS EMISSIONS
FROM AIRCRAFT EQUIPPED WITH
TURBOFAN, TURBOJET, AND
TURBOPROP ENGINES

Federal Aviation Administration
Office of Environment and Energy
and
U.S. Environmental Protection Agency
Office of Transportation and Air Quality

Version 1.0
Final Review Draft
February 28, 2009

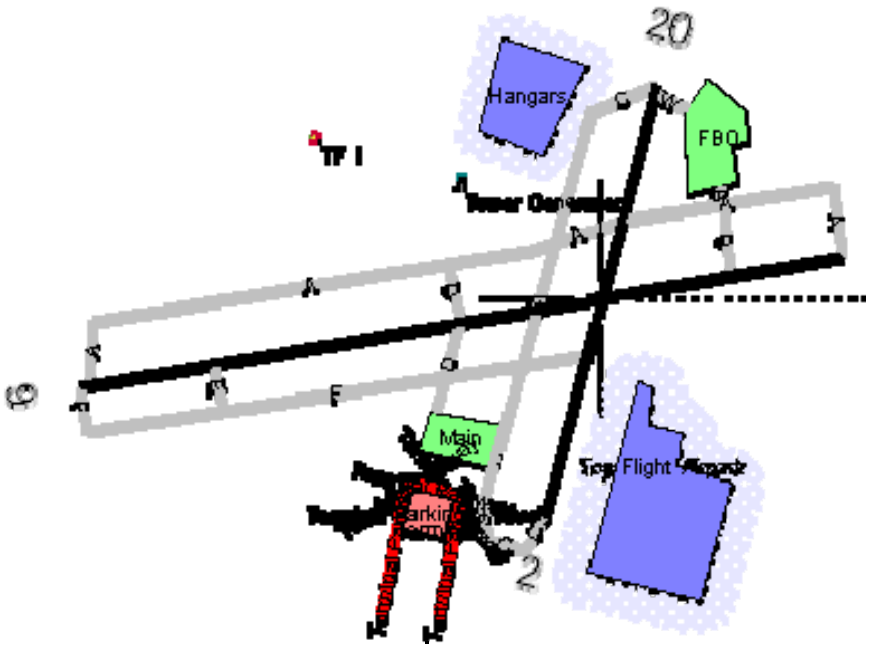
Emissions and Dispersion Modeling System v5.1



- **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

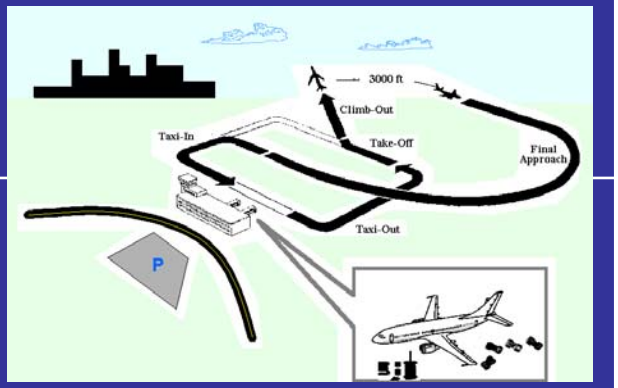
Emissions and Dispersion Modeling System v5.1

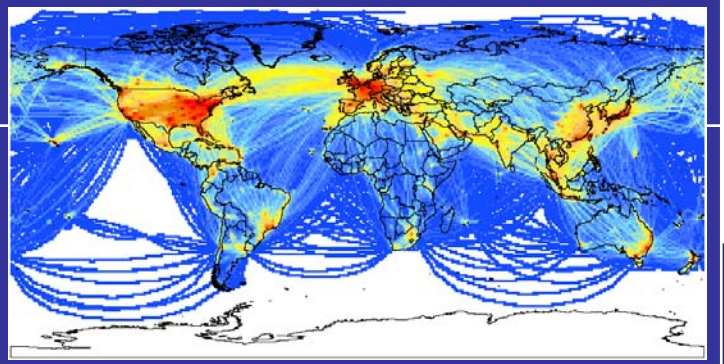
- Dispersion Analyses
  - User Input Airport Layout
    - Gates, Taxiways, Queues, Runways, etc…
  - AERMOD
  - AERMET
  - AERMAP



Leveraging Our Current Legacy Systems

Tools	Environmental Consequence
Emissions Dispersion Modeling System	Individual Airport Emissions Inventories / Concentrations
Integrated Noise Model	Individual Airport Noise Contours
Noise Integrated Routing System	Regional Noise Impacts from changes to Airports + Airspace ***ATO Tool***
MAGENTA	*Model for Assessing Global Exposure to Noise from Transport Airplanes* U.S. Flight Plan Inventories Global Noise Exposure
System for Assessing Aviation Global Emissions	Global Emissions Inventories



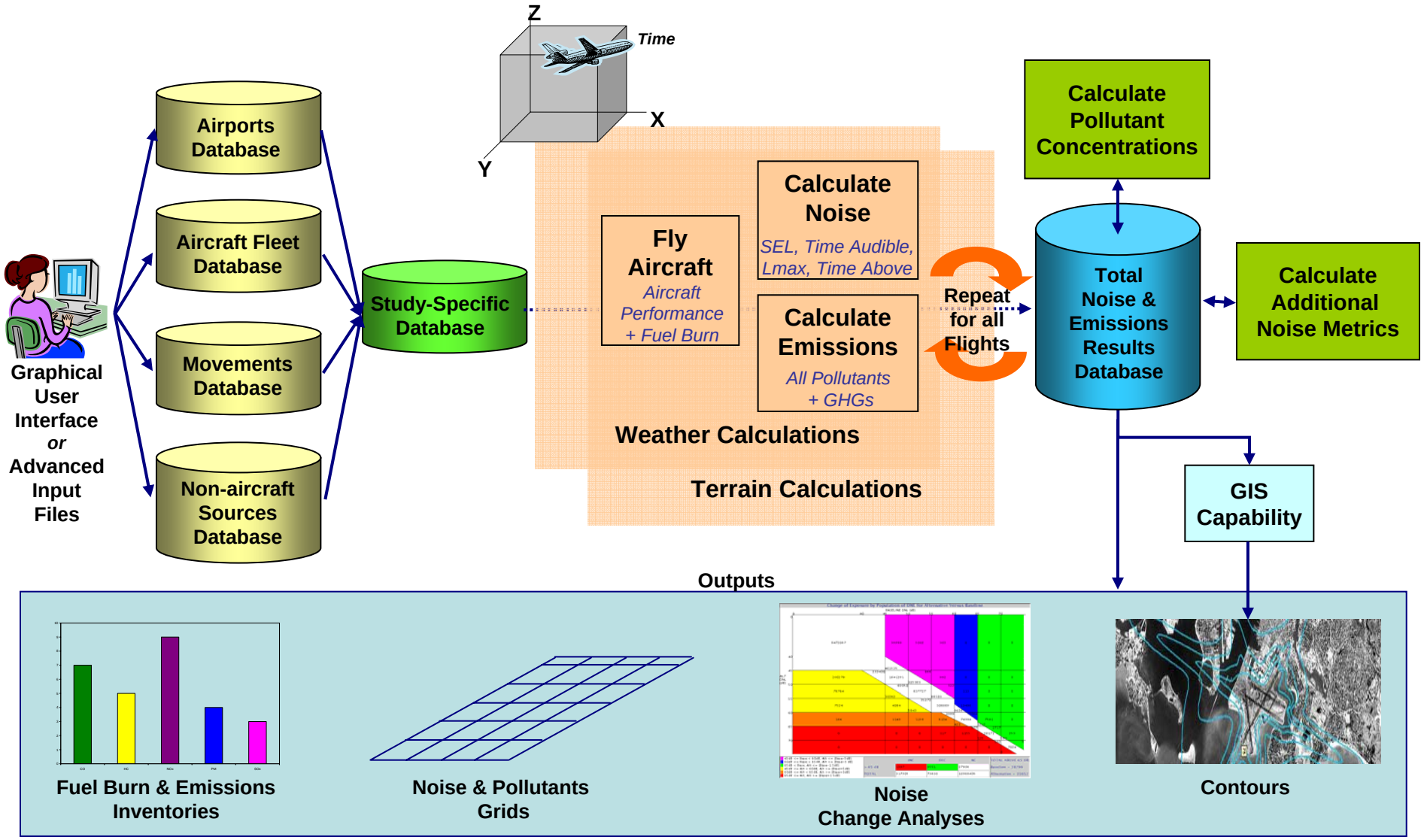


Aviation Environmental Design Tool

- **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



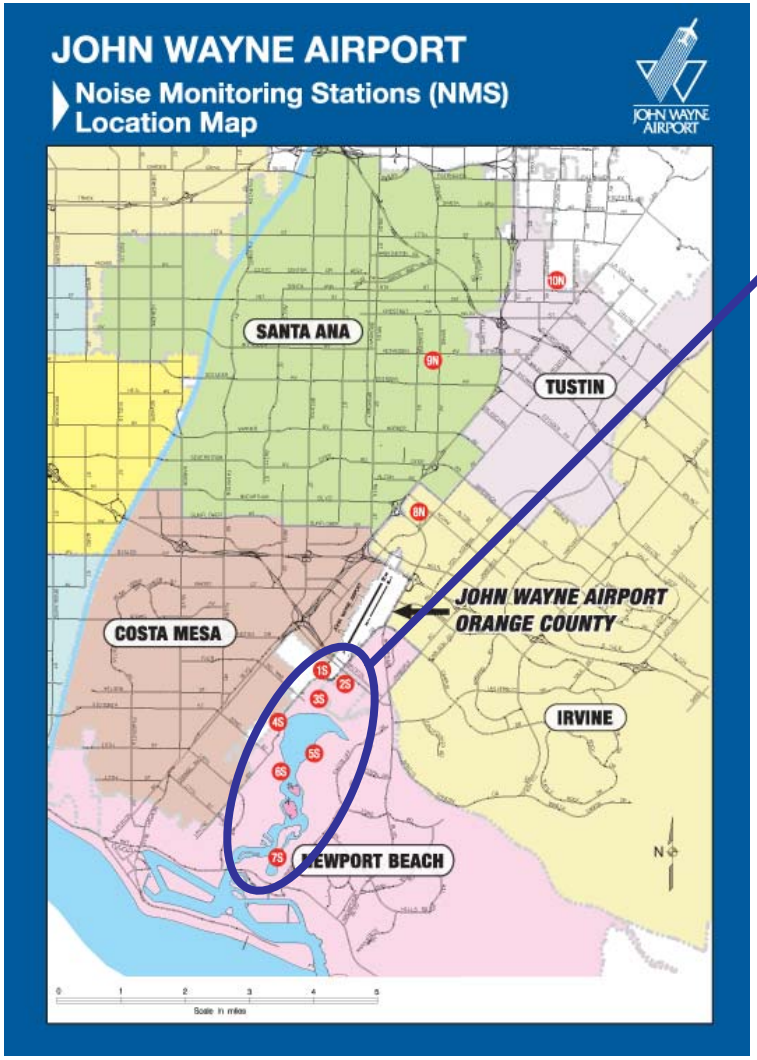
AEDT – Value Added…

- ***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**

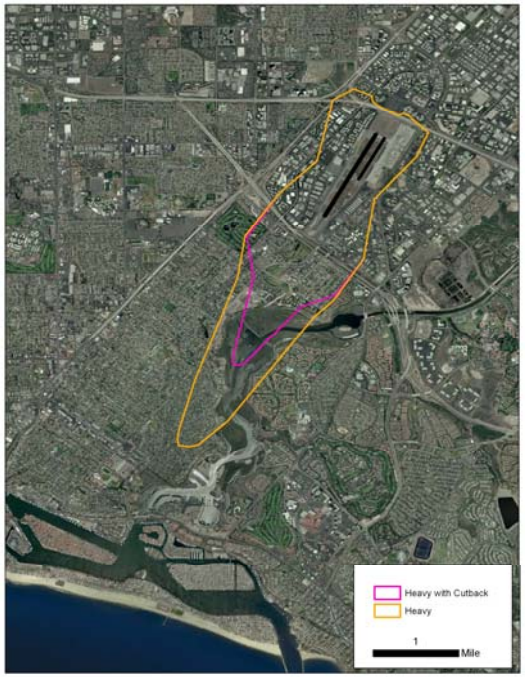
- **Public release of AEDT 2.0 planned in Dec 2011**
  - The official aviation environmental compliance & policy tool for the U.S.

Why AEDT?

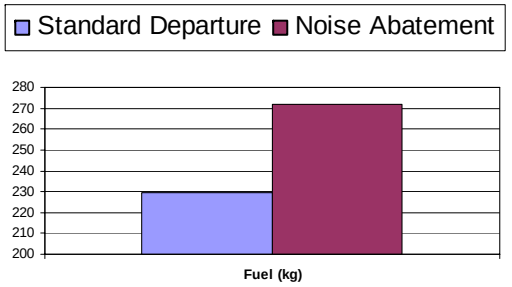
Informed Decision?



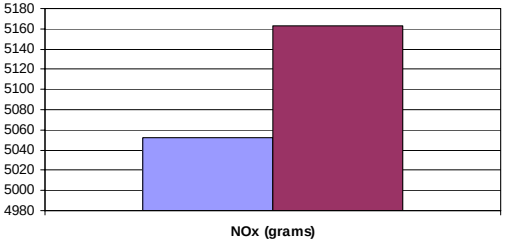
Noise abatement departure = quieter at monitors



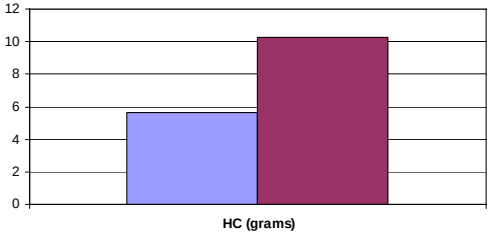
19% more fuel



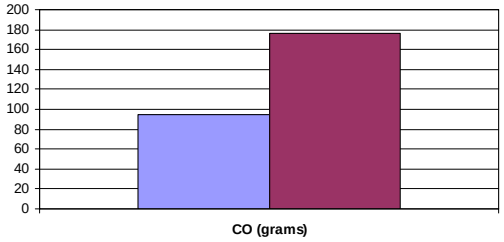
2% more NOx



82% more HC



85% more CO

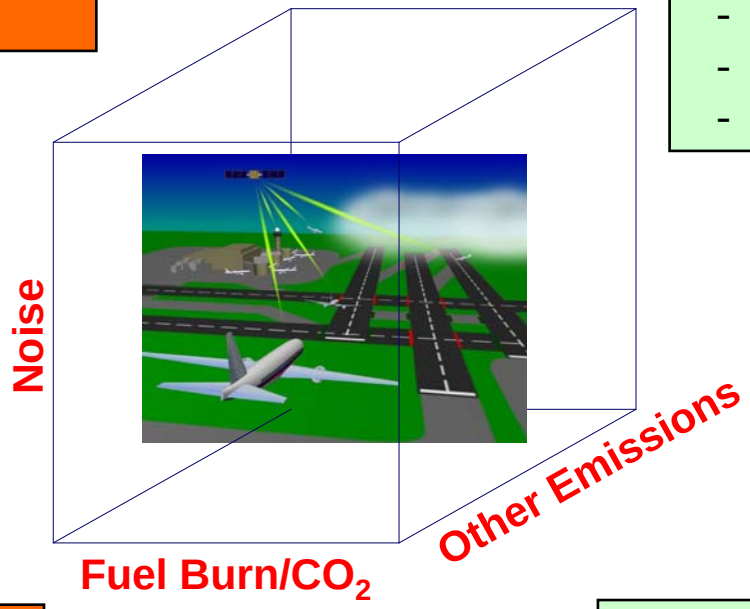


The Challenge: Trade-offs in Potential Solutions

Increased engine bypass ratio
- Reduced **Fuel Burn / CO_2**
- Reduced **Noise**
- Increased **NO_x**

Improved aerodynamic efficiency and reduced weight
- Reduced **CO_2**
- Reduced **Noise**
- Reduced **NO_x**

Nacelle Modifications
- Reduced **Noise**
- Increased **Fuel Burn/CO_2**

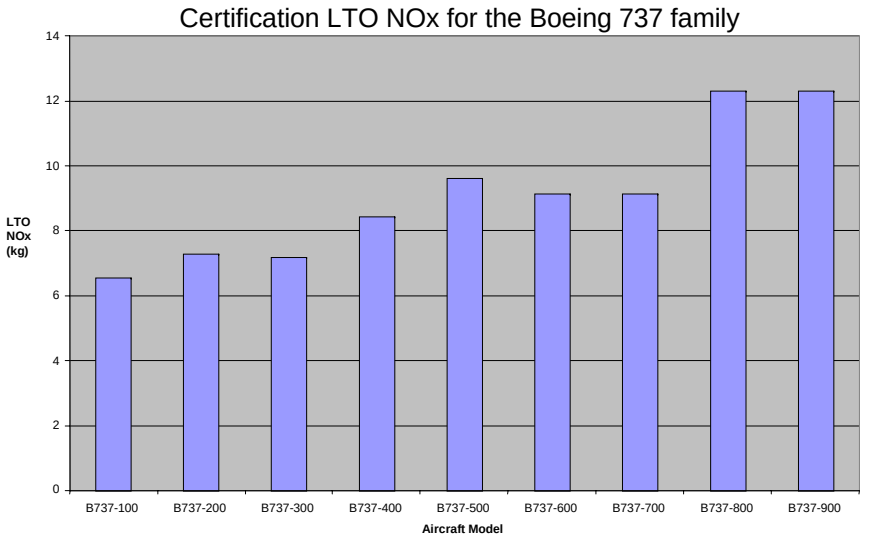


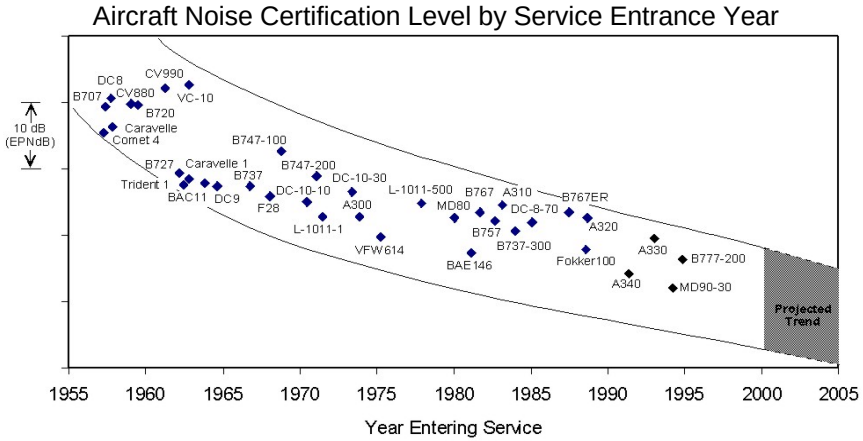
Increased Engine Pressure Ratio & Temperatures
- Reduced **Fuel Burn / CO_2**
- Reduced **HC** and **CO**
- Increased **NO_x**

Continuous Descent Approach
- Reduced **Noise**
- Reduced **Fuel Burn/CO_2**

Why AEDT?

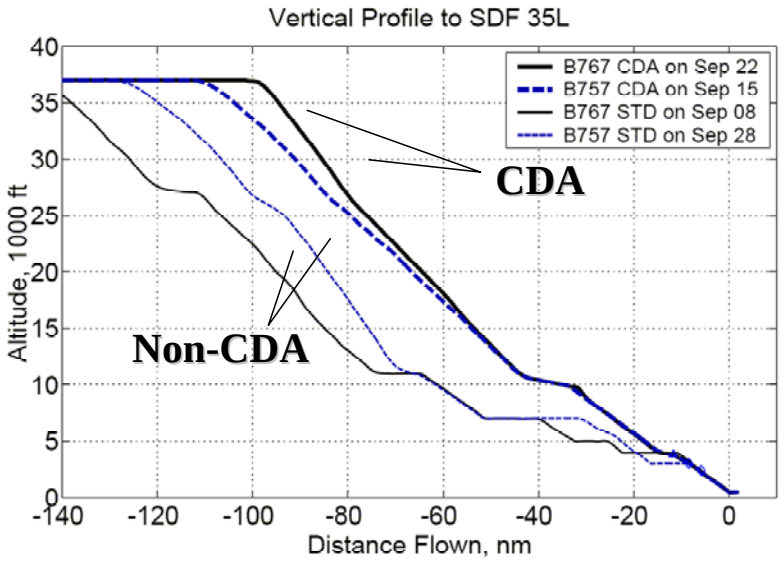
- **Noise & emissions tradeoffs dominate when analyzing aviation environmental effects**
  - Local, Regional, Global
- **Stovepiped legacy tools**
  - Different/conflicting datasets & algorithms to analyze the same system
- **It's all about "*making the <u>informed</u> decision.*"**



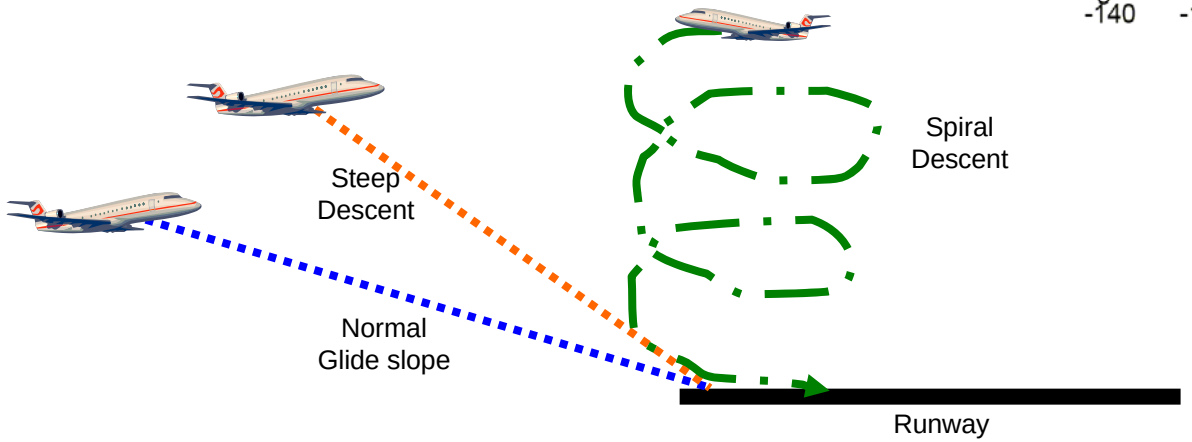


Challenges w/ Accuracy & Fidelity

- **Critical Need:**
  - Match simulation accuracy with environmental consequence fidelity



Single procedure



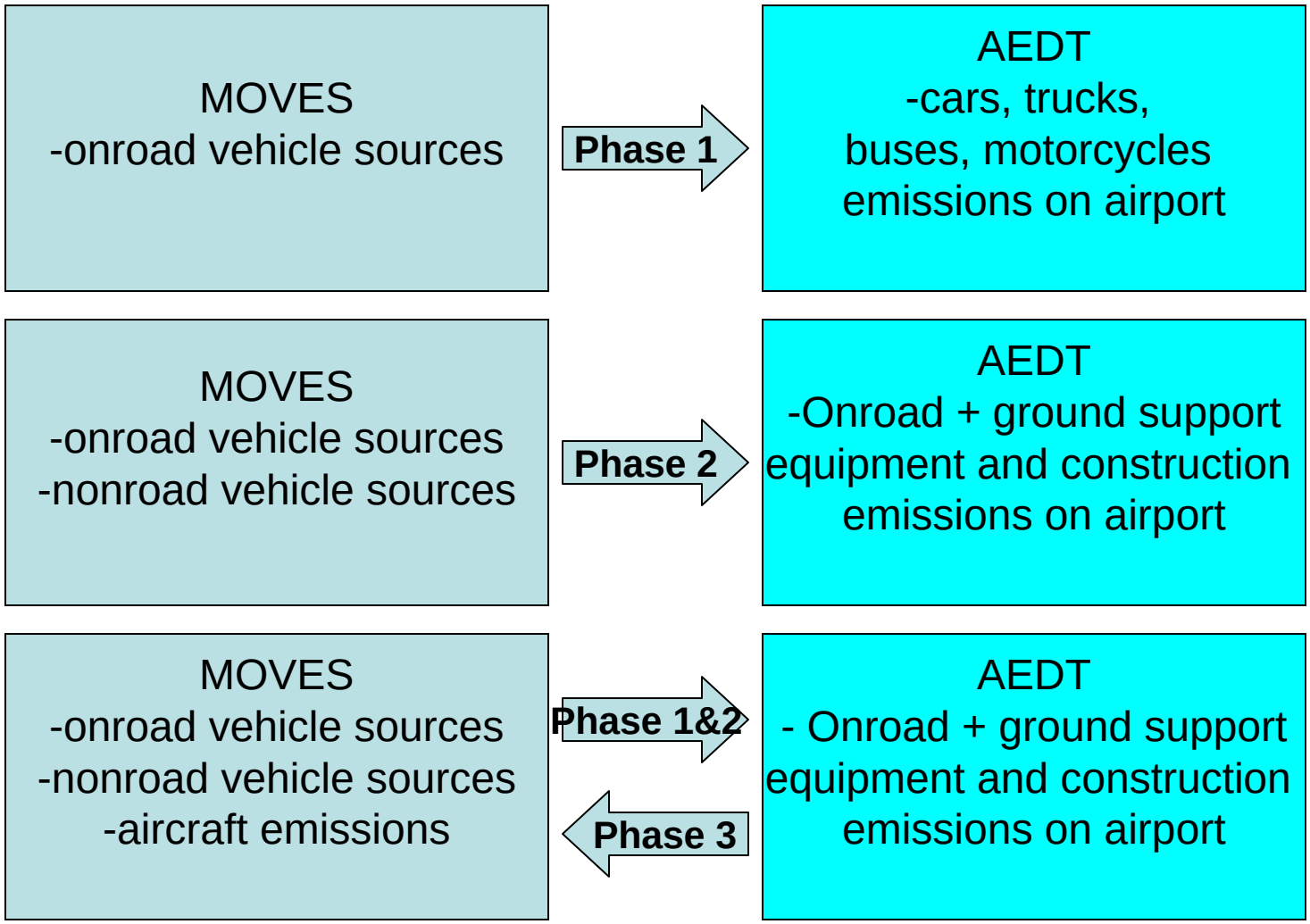
High Density scenarios

Compatibility with EPA Tools

AEDT and MOVES Requirements

	AEDT	MOVES
SQL Relational Databases	YES!	YES!
Dual Core Processors	YES!	YES!
1 GB RAM Memory	YES!	YES!
40 GB Storage	YES!	YES!
Windows Operating System	YES!	YES!

Potential Linkages with MOVES



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?

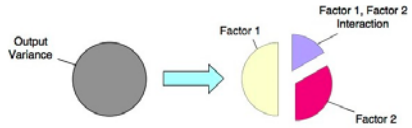
Building Confidence in the use of our Tools

Assessment

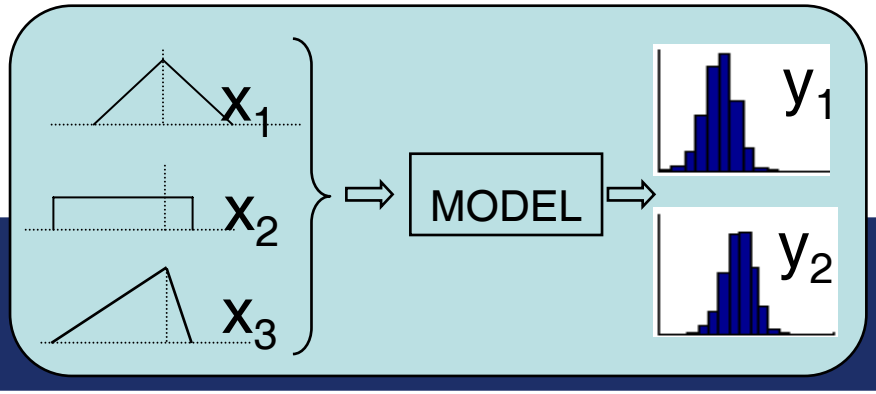
- **Objectives**
  - Provide sensitivity analyses of output response to uncertainties in input parameters and assumptions.
  - Identify gaps in functionality
    - Identify high-priority areas for further development
  - Contribute to the development of external understanding of AEDT.
  - Establish procedures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

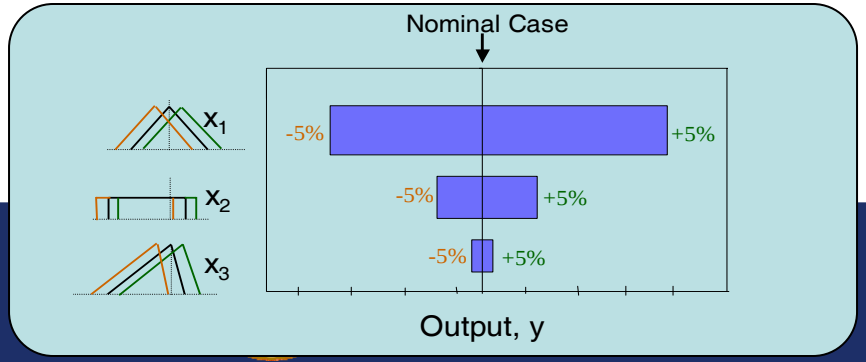
- **Analyses Types**
  - Monte Carlo Simulations
    - Random sample is drawn and run through module, resulting in an output
    - Cycle is performed hundreds to thousands of time, resulting in a set of outputs, which can be used to estimate means, variances, etc
  - Distributional Sensitivity Analysis (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



Monte Carlo Simulation



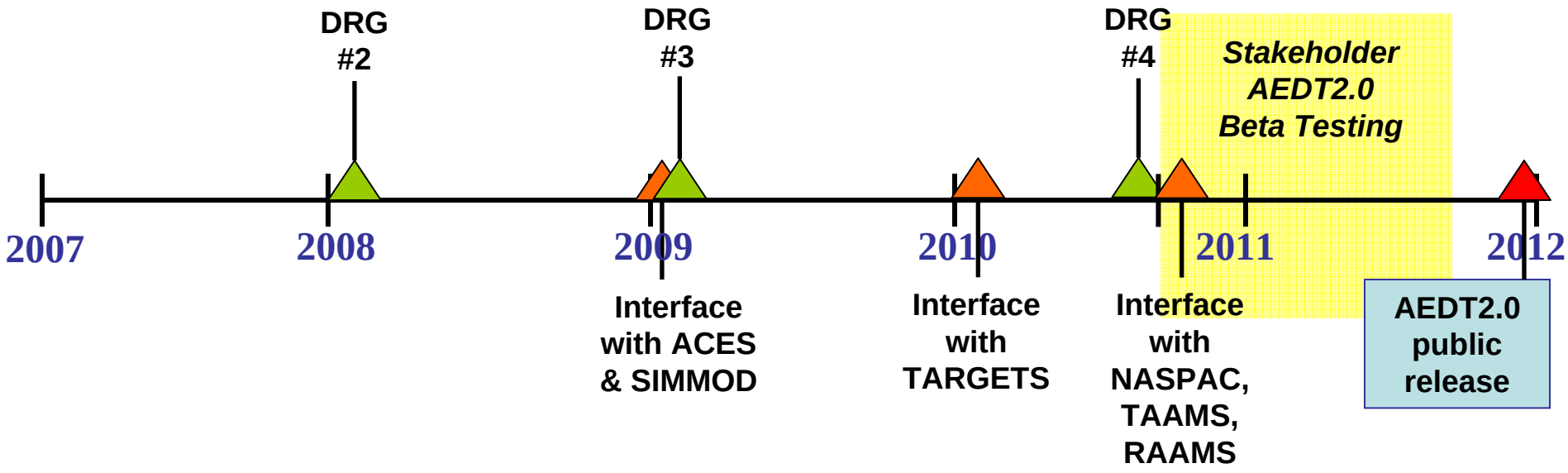
Distributional Sensitivity Analysis



AEDT Master Planning

AEDT Development Team

AEDT2.0 Development Timeline



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

Thank You!