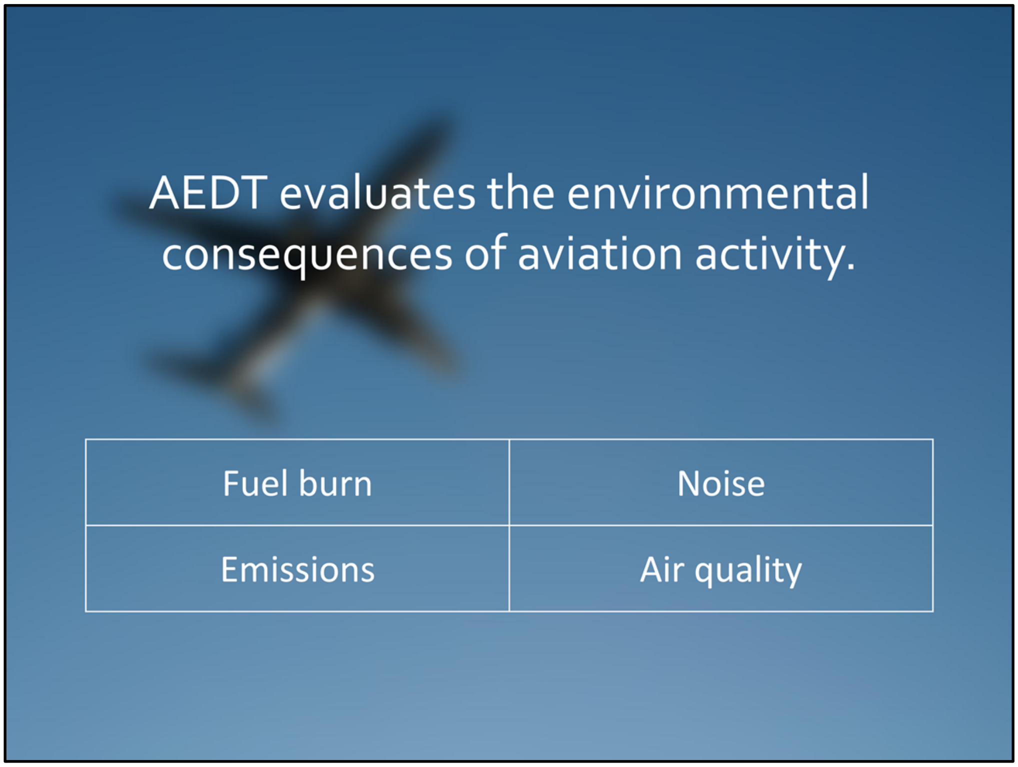
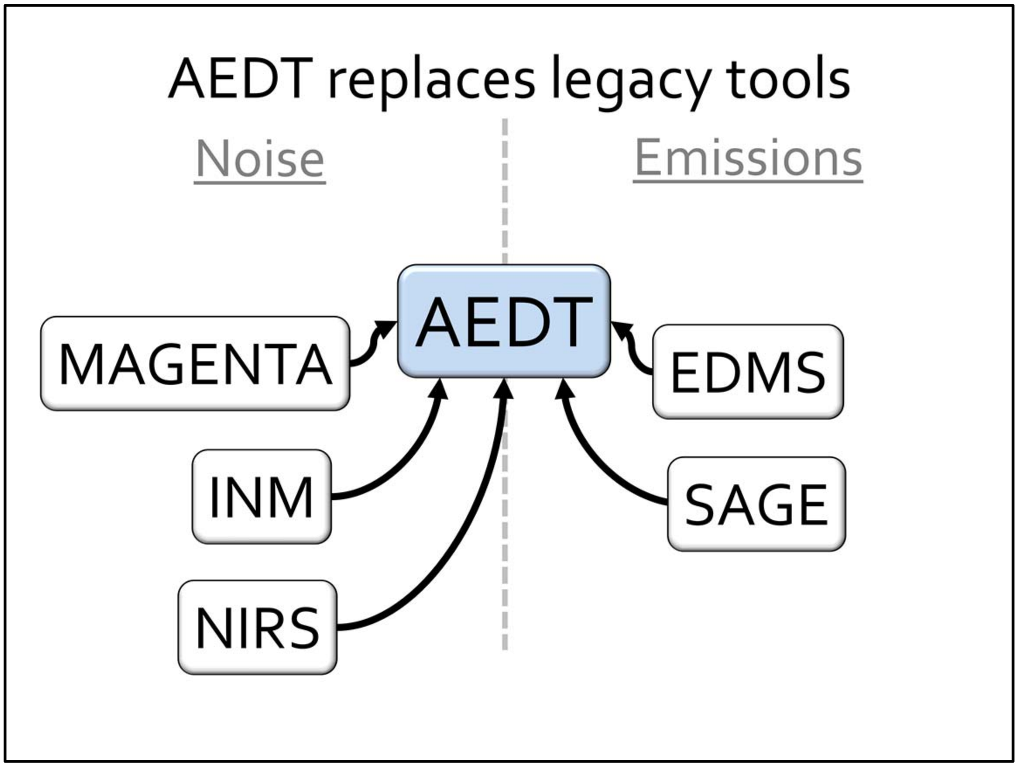
- Aviation Environmental Design Tool (AEDT) presentation to the American Association of Airport Executives Environmental Management Conference, June 2nd, 2014
- Presentation given by Chris Sequeira, FAA Office of Environment and Energy
- All photos by Chris Sequeira
- AEDT project managers
    - Fabio Grandi: AEDT co-manager, succeeding Becky Cointin
    - Chris Sequeira: AEDT co-manager, succeeding Ralph Iovinelli



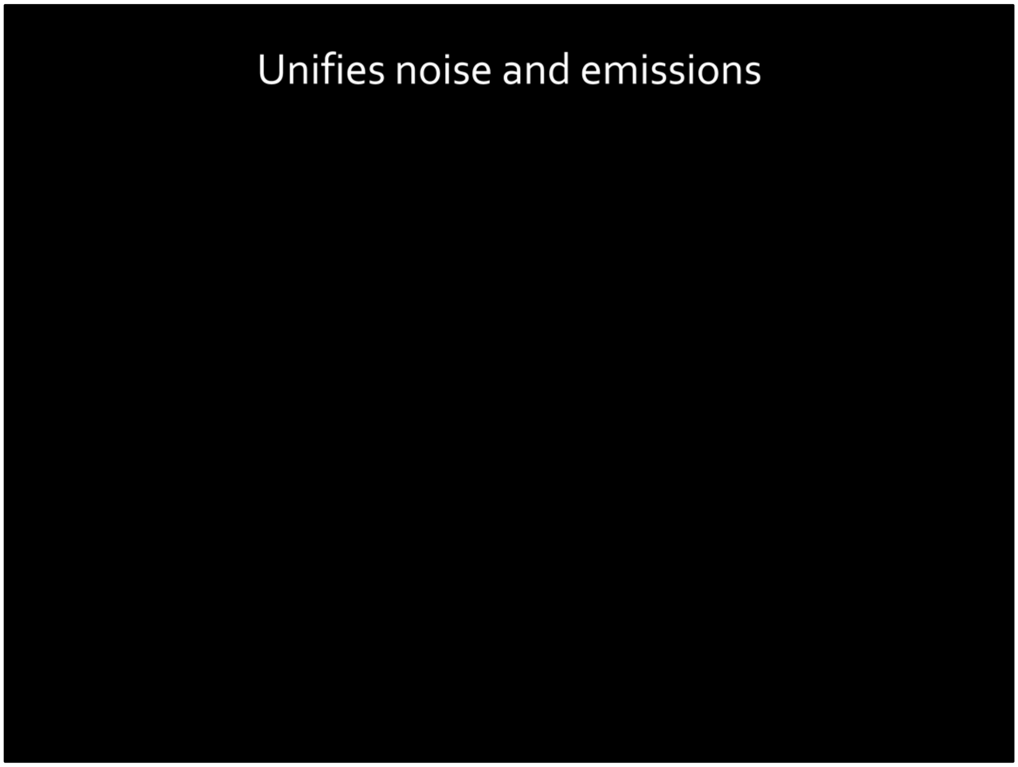
- AEDT evaluates the environmental consequences of aviation activity.
    - Fuel burn
    - Noise
    - Emissions
    - Air quality using AERMOD
    - Military aircraft from NOISEMAP included within AEDT



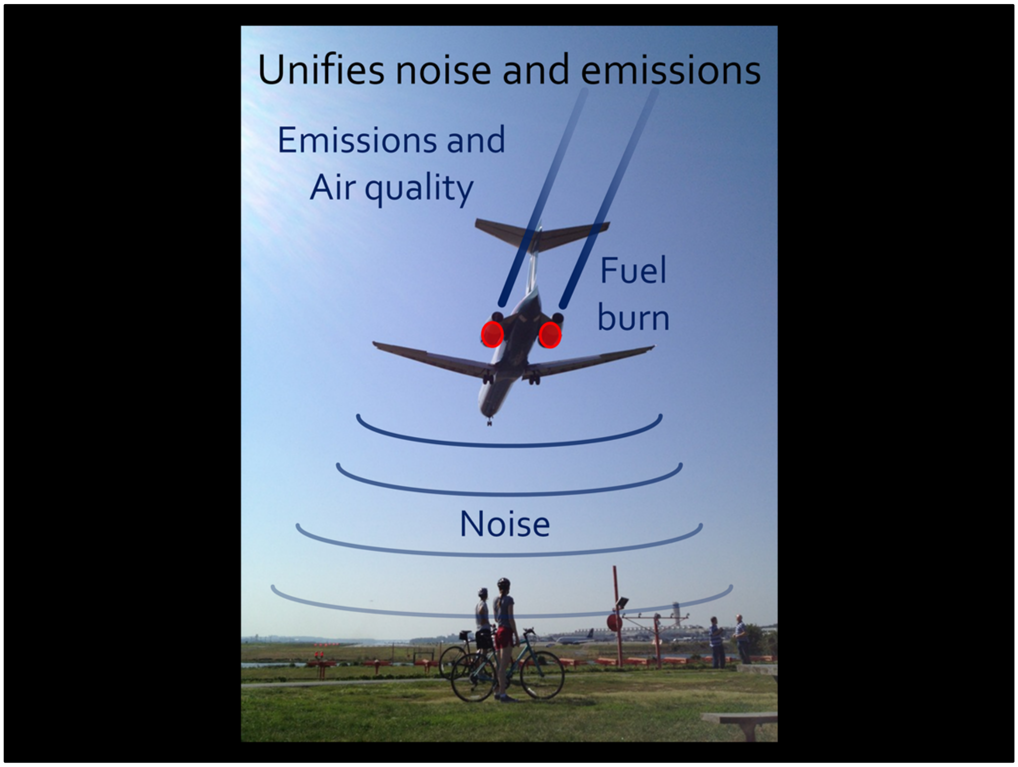
- Legacy tools:
  - Public regulatory tools
    - Integrated Noise Model (INM)
    - Noise Integrated Routing System (NIRS)
    - Emissions and Dispersion Modeling System (EDMS)
  - FAA-internal domestic and international policy analysis tools
    - System for Assessing Aviation's Global Emissions (SAGE)
    - Model for Assessing Global Exposure to the Noise of Transport Aircraft (MAGENTA)
- Functionality of all five tools will exist in AEDT

What makes AEDT better?

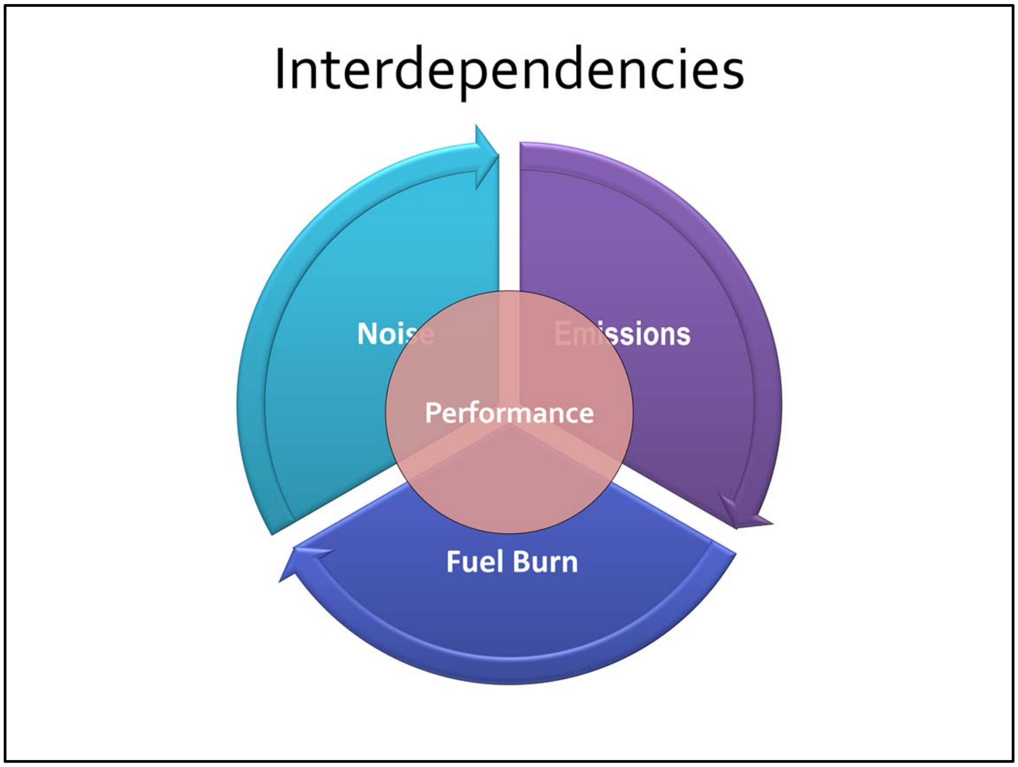
- What makes AEDT 2b better than the tools it's replacing?



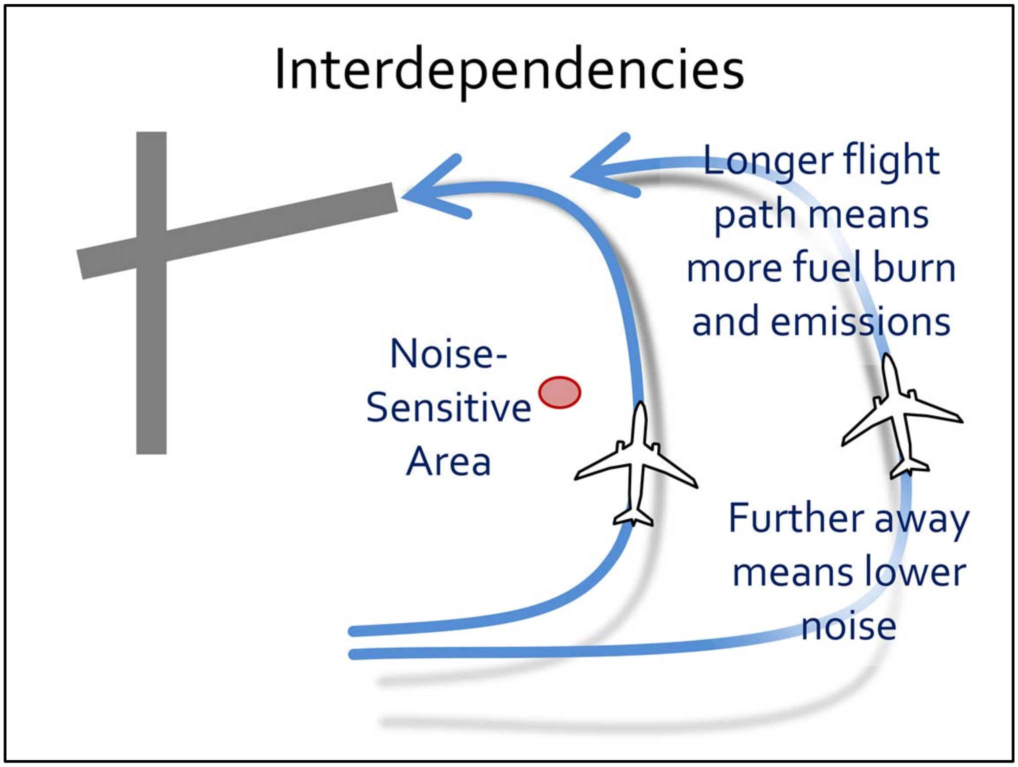
- Why was AEDT created?
  - AEDT was created to unify noise and emissions analysis in the same software tool
- Previously, you had to use separate tools for noise and emissions
  - INM: fly aircraft, get single-airport noise
  - NIRS: fly aircraft, get noise for air traffic airspace and procedure actions
  - EDMS: fly aircraft, get single-airport emissions and local air quality consequences
  - SAGE: fly aircraft, get domestic and global fuel burn and emissions
  - MAGENTA: fly aircraft, get domestic and global noise



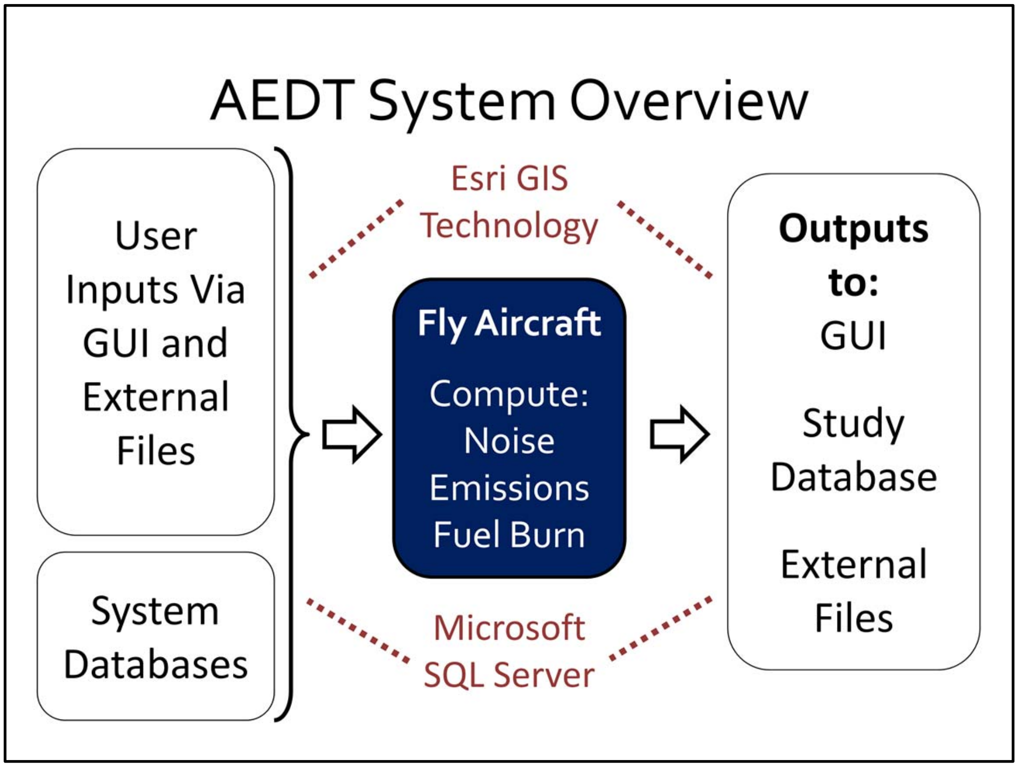
- AEDT: Get fuel burn, noise, emissions, and air quality consequences in the same tool



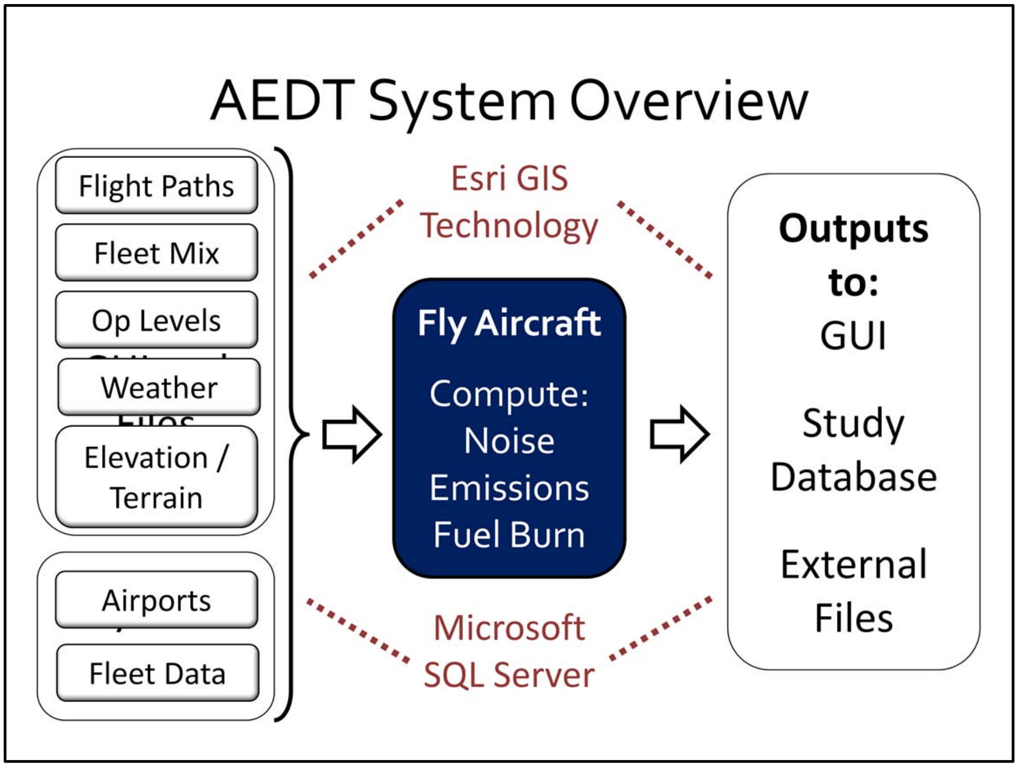
- Noise, emissions, and fuel burn are highly interdependent and occur simultaneously throughout all phases of flight
    - The unifying factor: aircraft performance
- AEDT can show how scenario changes made to respond to one environmental consequence area can affect other environmental consequence areas



- Imagine two situations:
- The original flight path takes the aircraft right next to the noise-sensitive area
- An alternate flight path take the aircraft further away from the noise-sensitive area
  - Further away means lower noise
  - However, longer flight path means more fuel burn and emissions



- Primary categories of user inputs:
  - Aircraft flight paths
  - Fleet mix
  - Number of operations
  - Weather
  - Elevation/terrain information
- Primary categories of system inputs
  - Airports
  - Fleet data
- Geographic information system (GIS)-based: uses latitude and longitude coordinates
  - Leverages Esri GIS technology
- Graphical user interface: enables user to drive the software through mouse point and click
- AEDT databases are relational databases with Structured Query Language (SQL)
  - Leverages Microsoft SQL Server technology
  - Default system databases contain information on fleet (3200+ airframe/engine combos), airports (35,000+ airports globally)
  - Outputs are stored in relational databases
  - Scaleable from a single flight to global (yes, it’s possible to put tens of millions of flights into AEDT)
- External files: enables import of data and studies
  - AEDT Standard Input File (ASIF): human-readable universal input file format for AEDT



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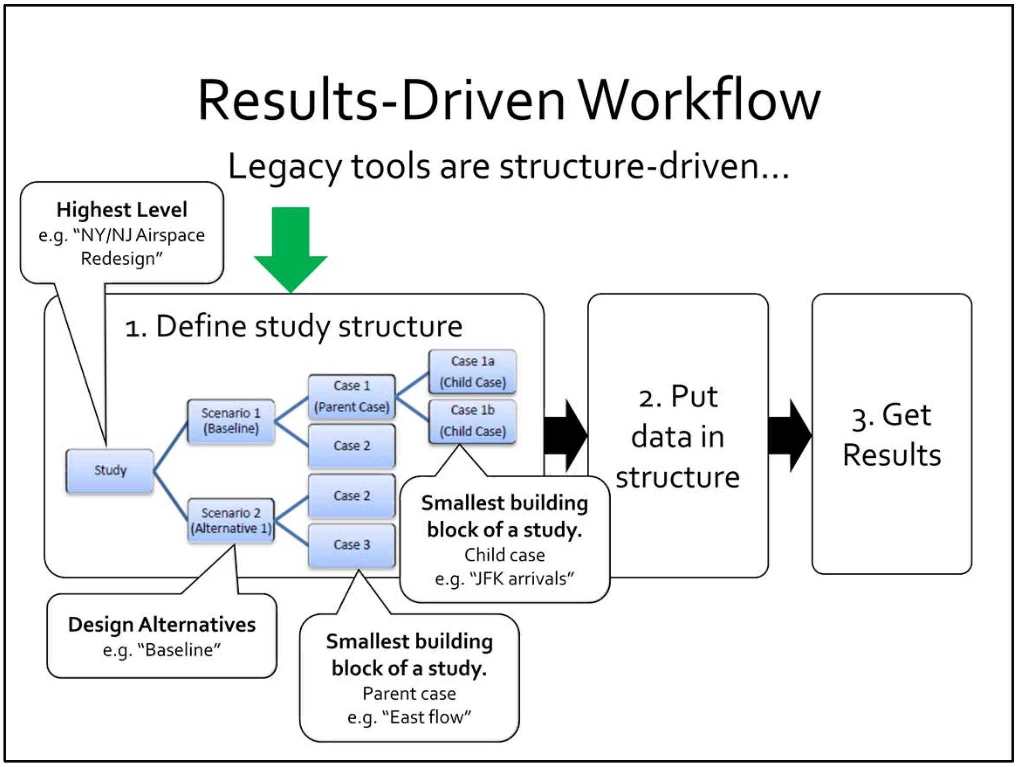
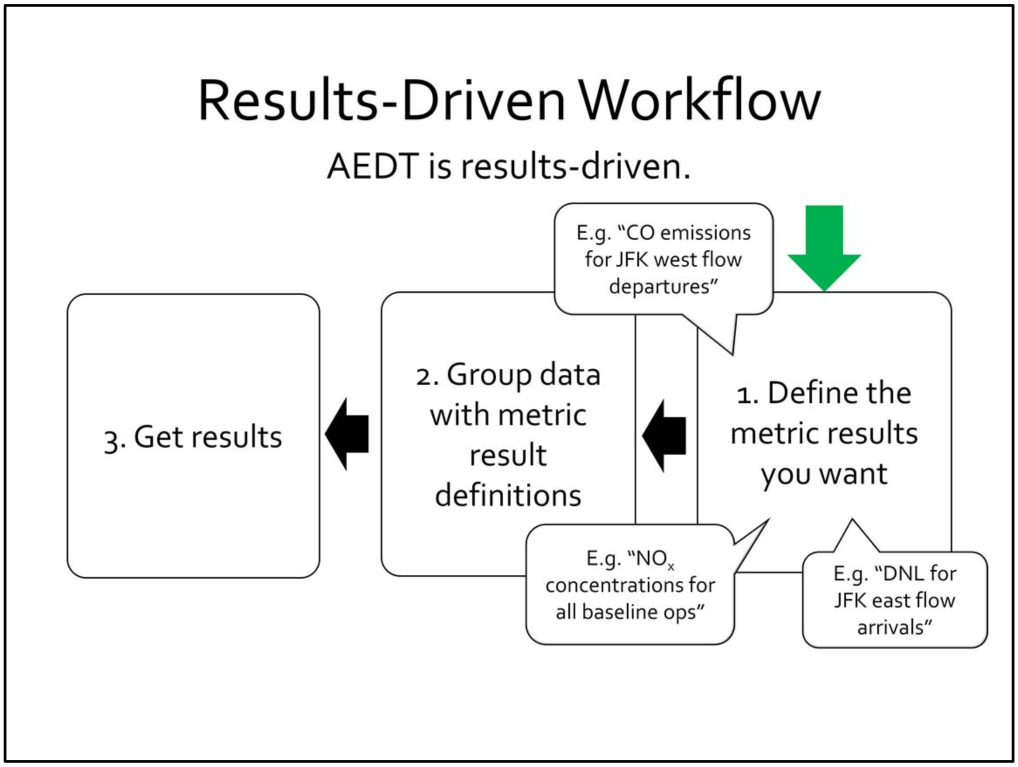
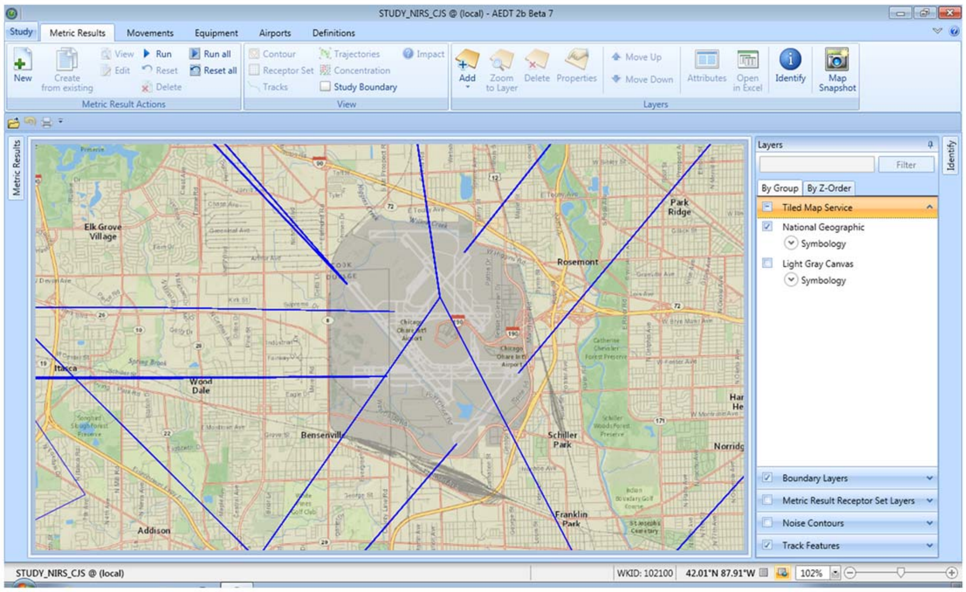


- The legacy tools are driven by structure.
- Working from left to right:
    - Define structure first
    - Then put data into the proper structural elements
    - Then run study and get results
- Must remember why you structured your study in a certain way
    - Anyone else who works with your study also must understand your structure!
- To reorganize your data, must redesign and redefine your study structure!



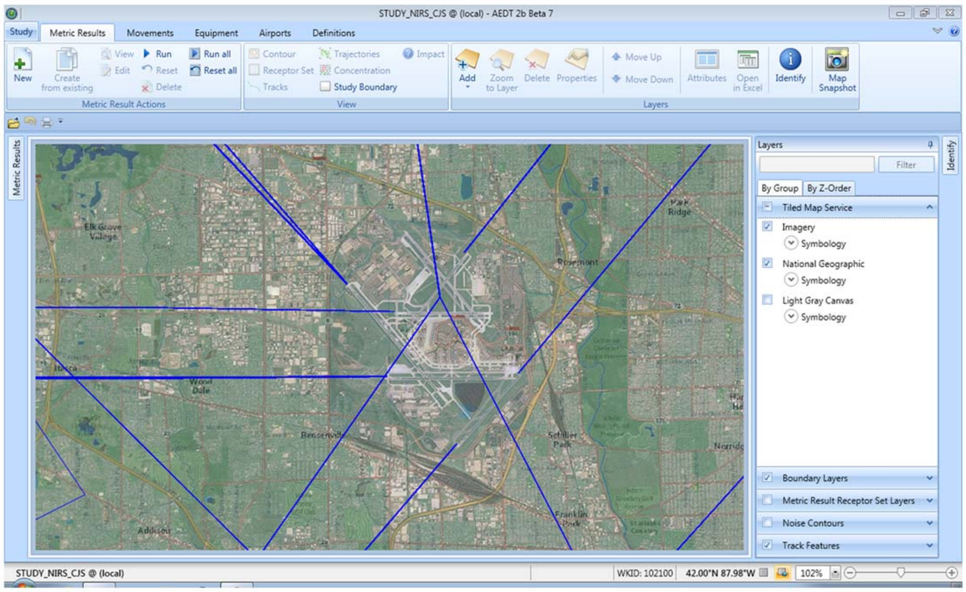
- AEDT is driven by results.
- Working from right to left:
    - Define the results you want
    - Then link data with the results definitions
    - Then run the definitions and get results.
- No rigid structure to remember; can group data however you want!
    - Can put the same data into multiple metric results definitions and multiple groups

Built-in geographic information system (GIS)



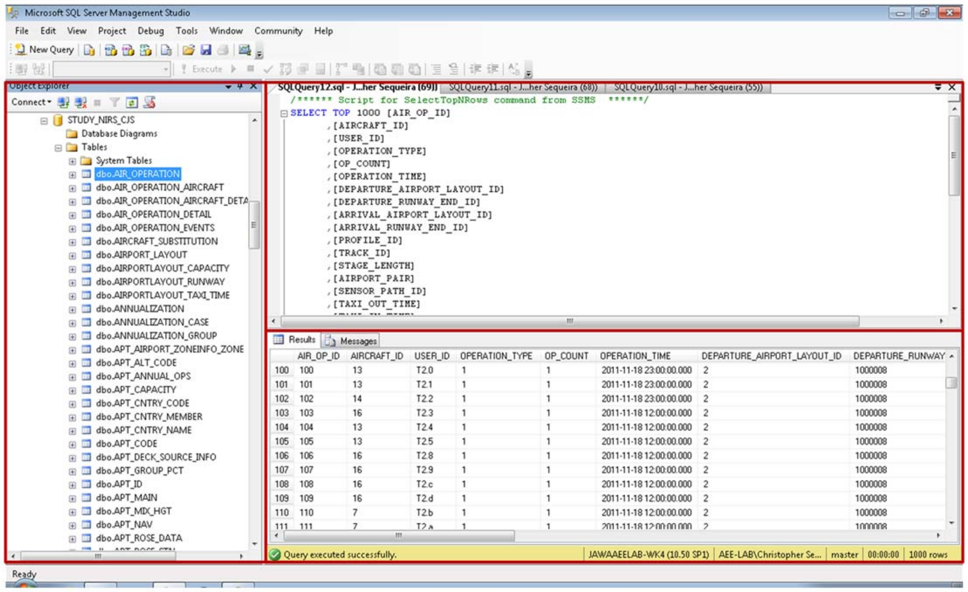
- AEDT has a built-in geographic information system (GIS)
- Leverages Esri GIS technology
- With an internet connection, AEDT can access online basemaps, such as the streetmap shown in the picture
- You can import your own basemaps and shape files
- The blue lines are example flight tracks

Built-in geographic information system (GIS)

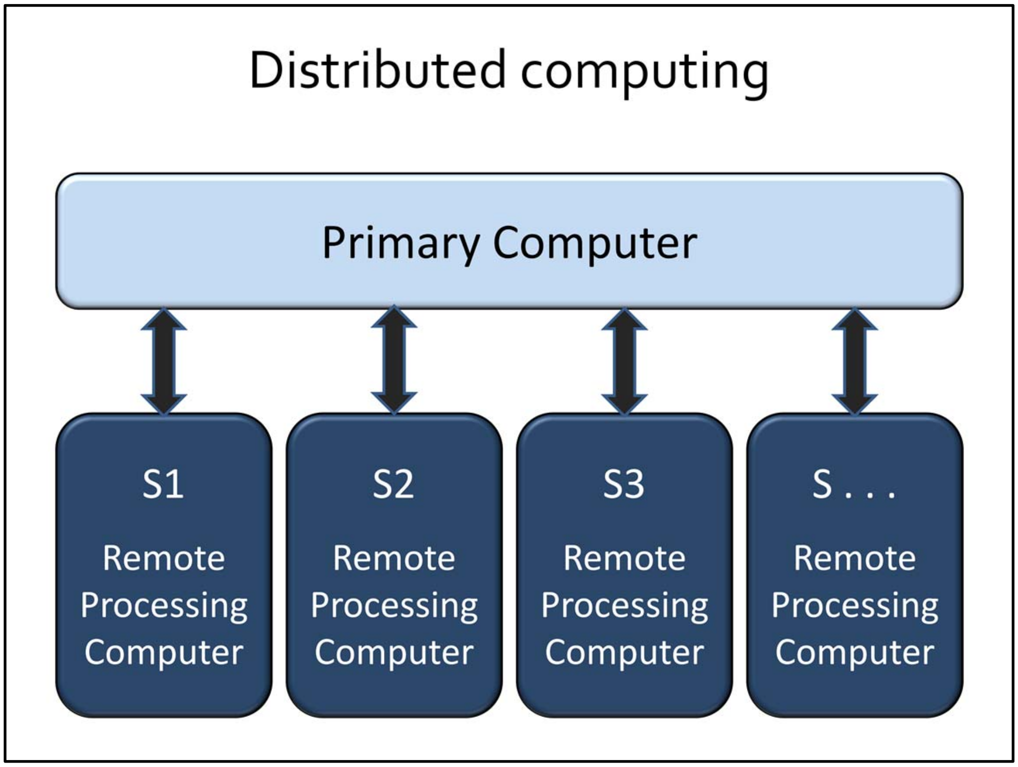


- Using layer controls, you can add multiple layers and blend them
- The screenshot shows a blend of streetmap and satellite imagery online basemaps
- The blue lines are example flight tracks

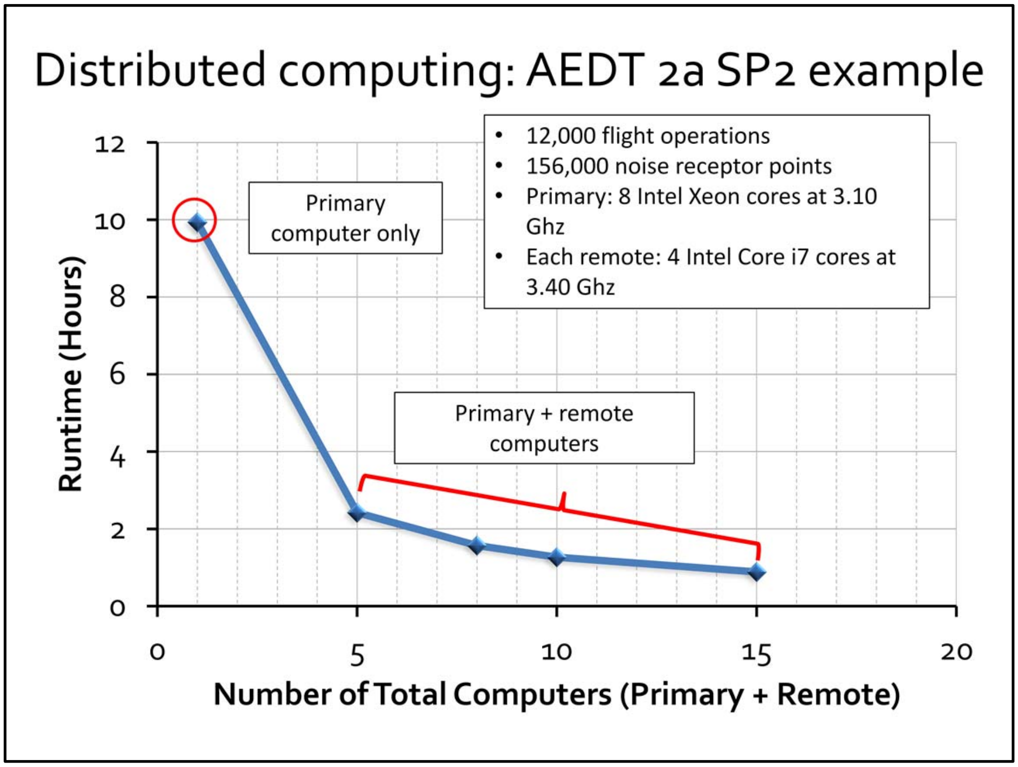
Relational databases with SQL



- AEDT is based around detailed relational databases with Structured Query Language (SQL)
- Leverages Microsoft SQL Server
- Microsoft SQL Server is the critical technology enabling scaling from a single flight to an entire global analysis
- Example: AEE created a global fuel burn and emissions inventory for the year 2010.
  - Over 28 million flights
  - Over 3500 airports
  - Database over 700 gigabytes in size
- This is a screenshot of Microsoft SQL Server Management Studio
  - Left pane shows a subset of tables in an AEDT study database
  - Upper right pane shows a SQL query used to show a subset of records in the table highlighted in the left pane
  - Lower right pane shows the results of the query



- AEDT is a multi-threaded application, to take advantage of multiple processor cores
- AEDT enables distributed computing (cooperative computer processing using multiple computers)
- AEDT full installation exists on the primary machine, known as the taskmaster (TM)
- Smaller AEDT installations exist on the remote processing computers
- Taskmaster and remote processing computers share workload, reducing study runtime



- Substantial decrease in runtime is possible by adding just a few remote processing computers
- Adding remote processing computers gives diminishing returns

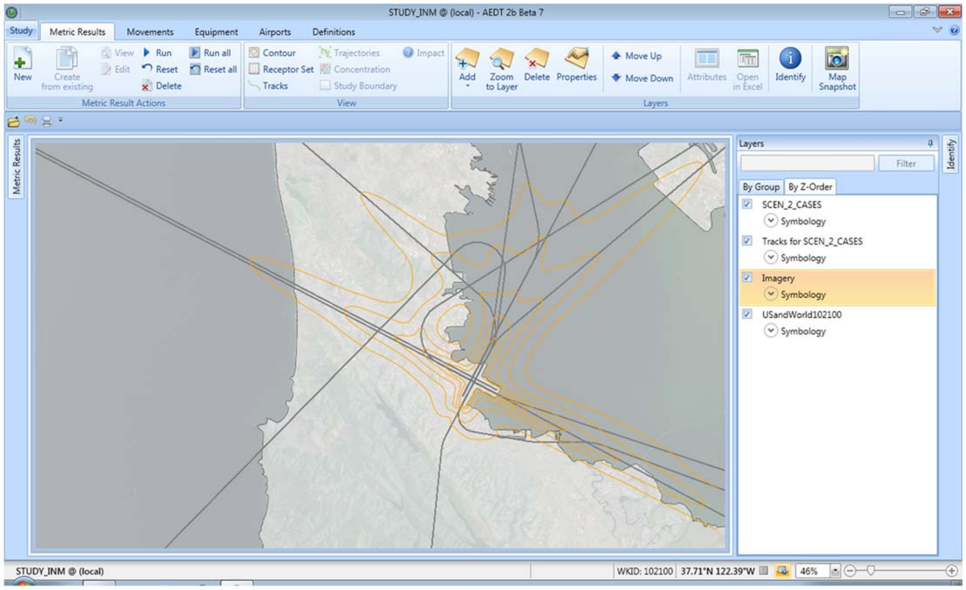

AEDT Version 2b

AEDT 2b's Intention

To replace AEDT 2a, INM, EDMS, SAGE, and MAGENTA for environmental compliance, research, and policy analysis.

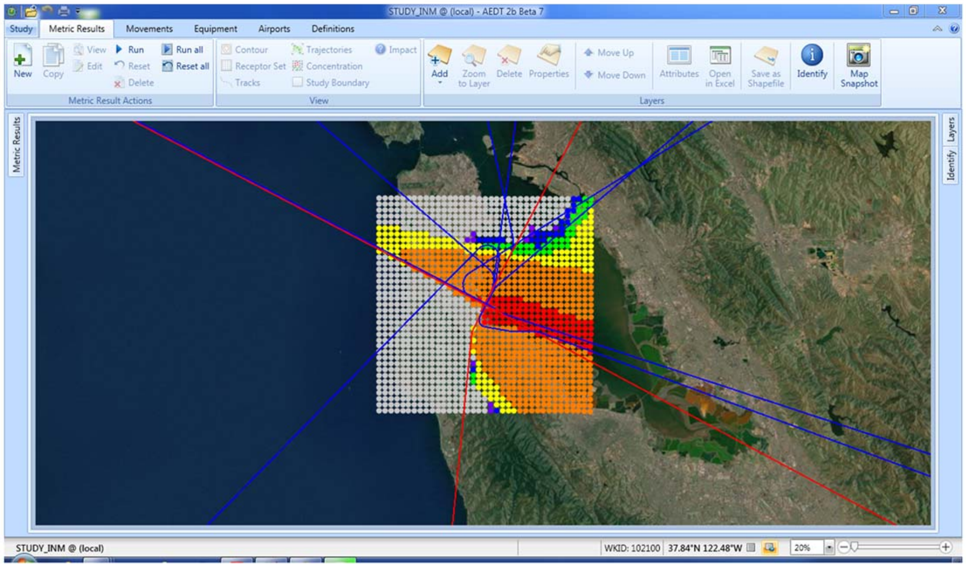
- What will AEDT 2b have that EDMS doesn't have?

Curved flight paths ...

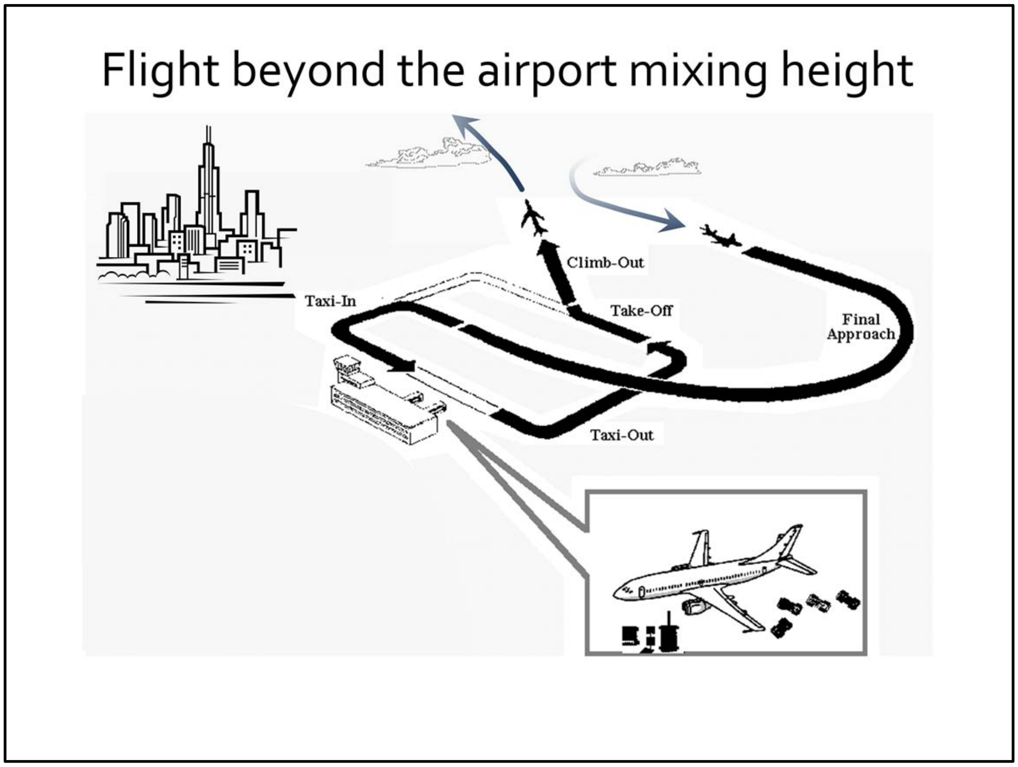


- AEDT 2b supports curved flight paths
    - EDMS has straight-in/straight-out flight paths only
- Three ways to input flight paths
    - Track nodes: user-specified points representing latitude/longitude locations along the flight track, with optional altitude controls
    - Track vectors: content representing straight paths with user-specified distances and curves with user-specified radii
    - Sensor paths: where AEDT takes user-specified radar data, smoothens it, and calculates aircraft performance
        - User-specified radar points contain latitude, longitude, and altitude
            - Points can also contain aircraft speeds above 10,000 feet AFE
        - AEDT then calculates the thrust needed to reach the given points

… with emissions dispersion

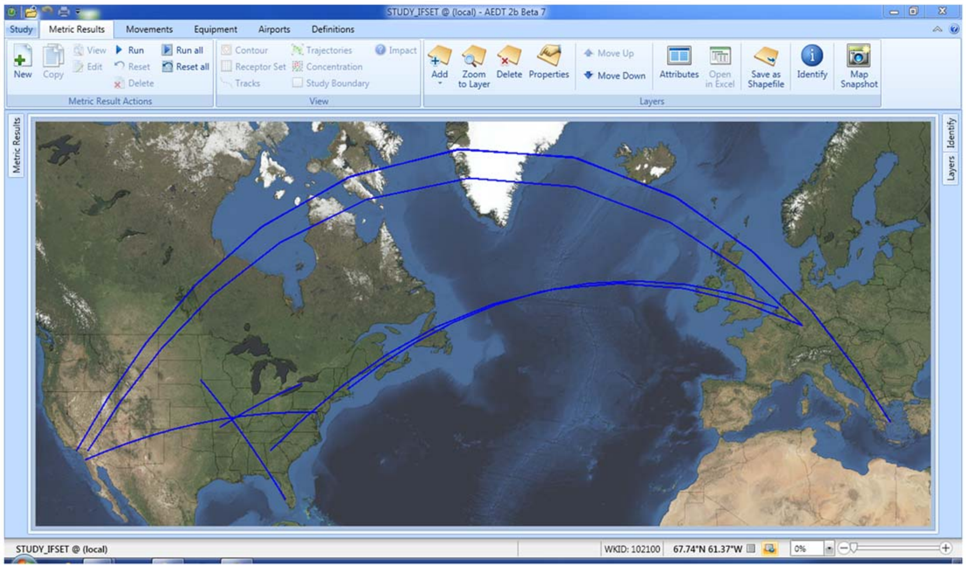


- These colored receptors show CO 8-hour concentrations from the curved flight tracks in the screenshot.
  - Gray: Concentrations essentially zero
  - Blue: Low concentrations
  - Red: High concentrations



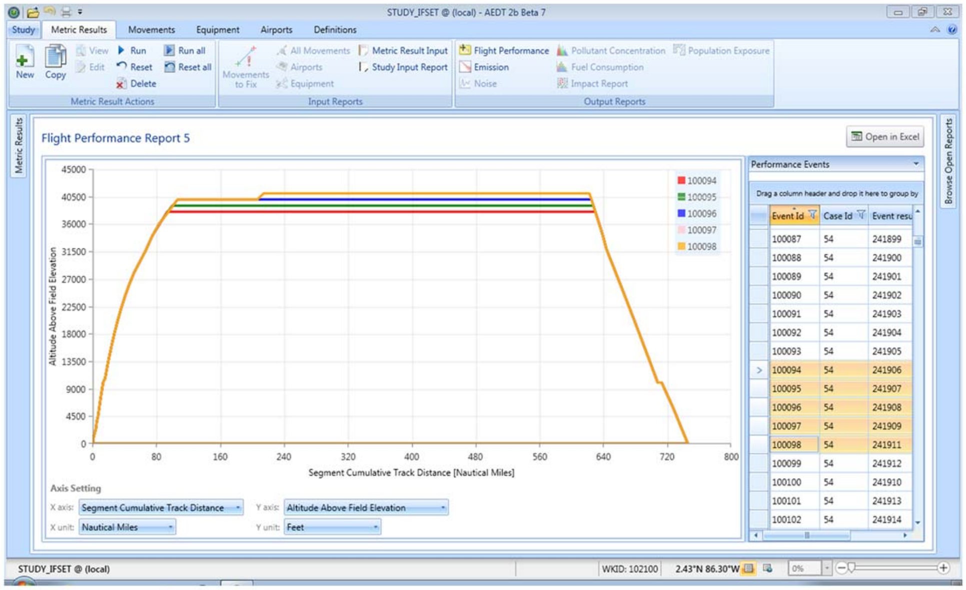
- AEDT can fly flights well beyond the airport mixing height

Flight beyond the airport mixing height

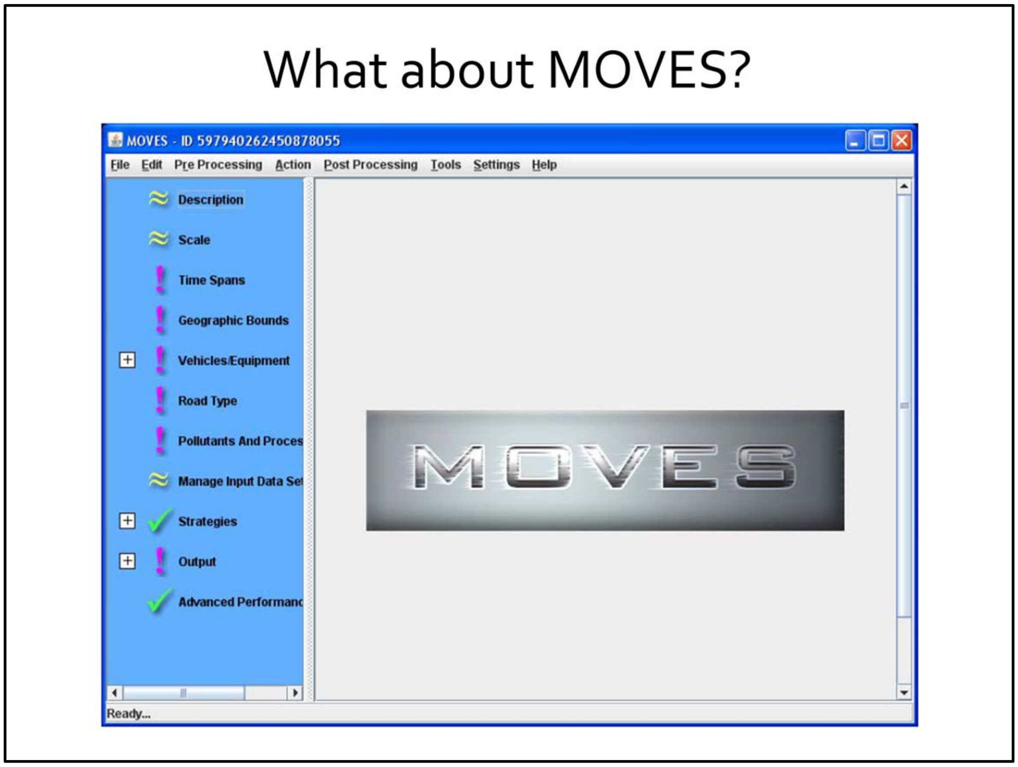


- AEDT can fly flights well beyond the airport mixing height … even from airport to airport!
- The blue trajectories are notional runway-to-runway flights between various airports
- FAA uses AEDT to generate runway to runway fuel burn and emissions inventories for domestic and international reporting and policy-making, including the ongoing CO2 standard-setting initiative within the International Civil Aviation Organization’s Committee on Aviation Environmental Protection

Flight beyond the airport mixing height



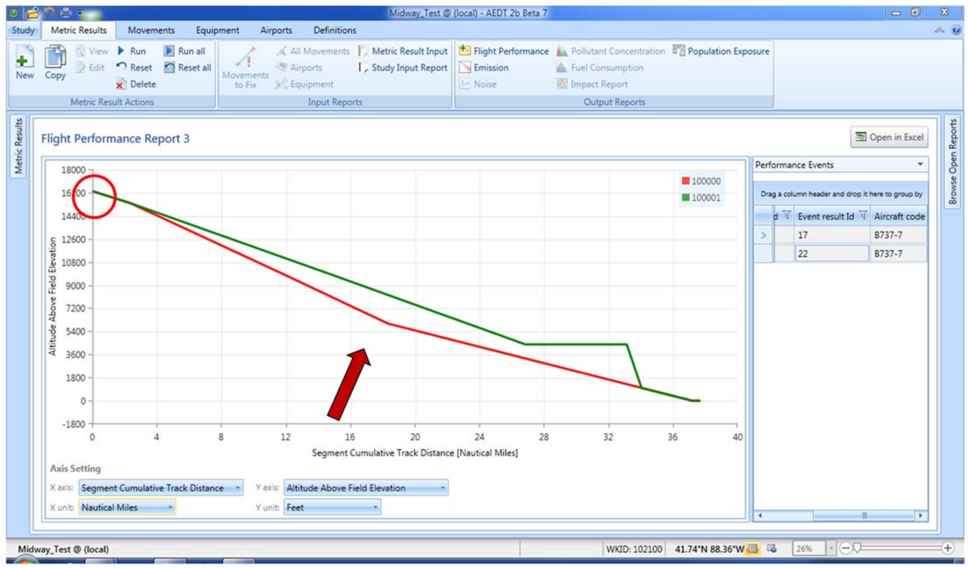
- The flight performance report in the screen shot shows the altitude profiles of several flights, including climb, cruise with step climbs, and descent



- AEDT will not include an integrated version of US EPA's Motor Vehicle Emissions Simulator MOVES), which is the replacement for EPA's MOBILE model for computing onroad mobile source ground emissions
- MOVES is a much more detailed model than MOBILE, and MOVES2014 is still in active development
- Screenshot source: MOVES2010b User Guide (PDF) (EPA-420-B-12-001b, June 2012)

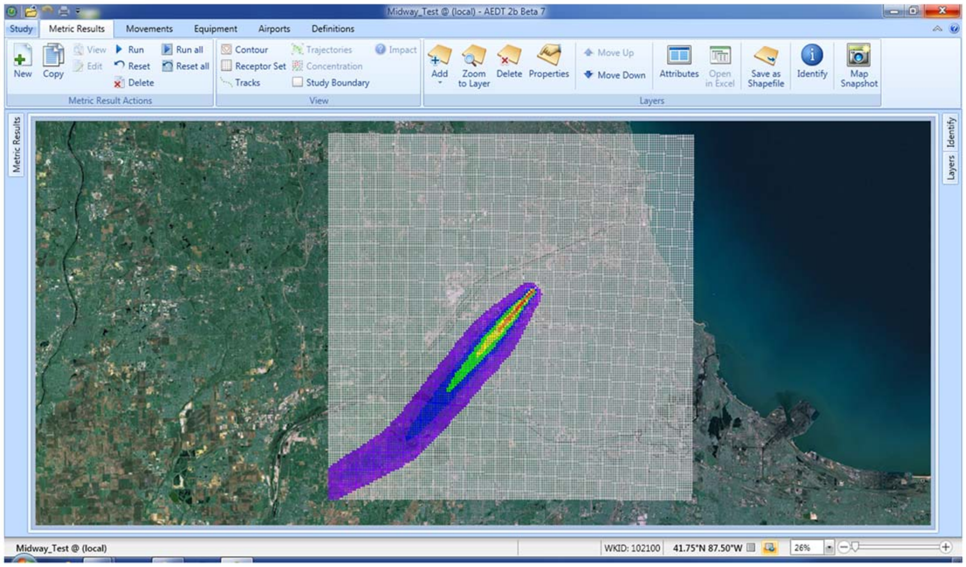

AEDT 2b: BEYOND INM

Altitude controls



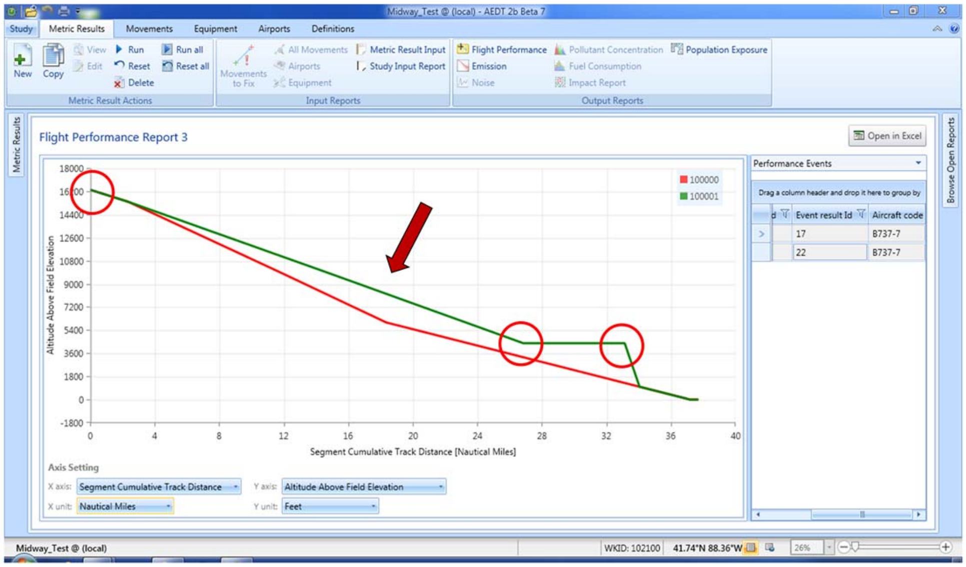
- Altitude control algorithms existed in NIRS but not in INM
- Altitude controls represent “air traffic control commands” for aircraft to fly at, above, or below certain altitudes
- Three types of altitude controls, with approximately +/- 300 foot tolerance
  - At: fly to maintain a user-specified altitude
  - AtOrAbove: fly to and remain at or above a user-specified altitude
  - AtOrBelow: fly to and remain at or below a user-specified altitude
- Altitude control algorithms are built into AEDT, so if changing aircraft vertical profiles using altitude controls, no need to produce a justification document package for FAA review and approval
- The two fictional aircraft approach vertical profiles in the screenshot each have an “At” altitude control at 16,000 feet AFE
- Let’s look at the fictional red profile, which has no further altitude controls

Altitude controls



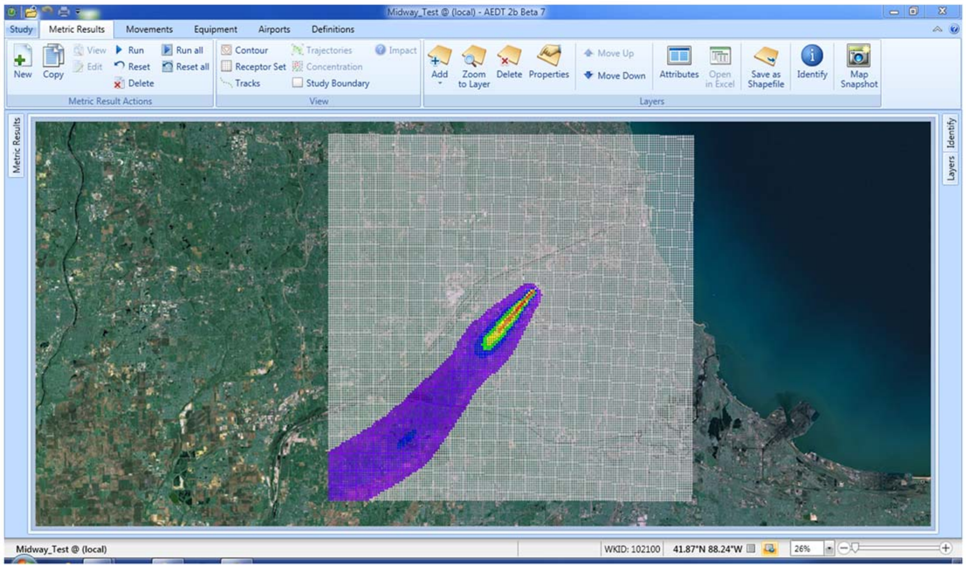
- 300 fictional flights flying in the daytime along the red profile give the colored noise receptor grid shown here.
    - Purple colors: lower noise
    - Red colors: higher noise

Altitude controls



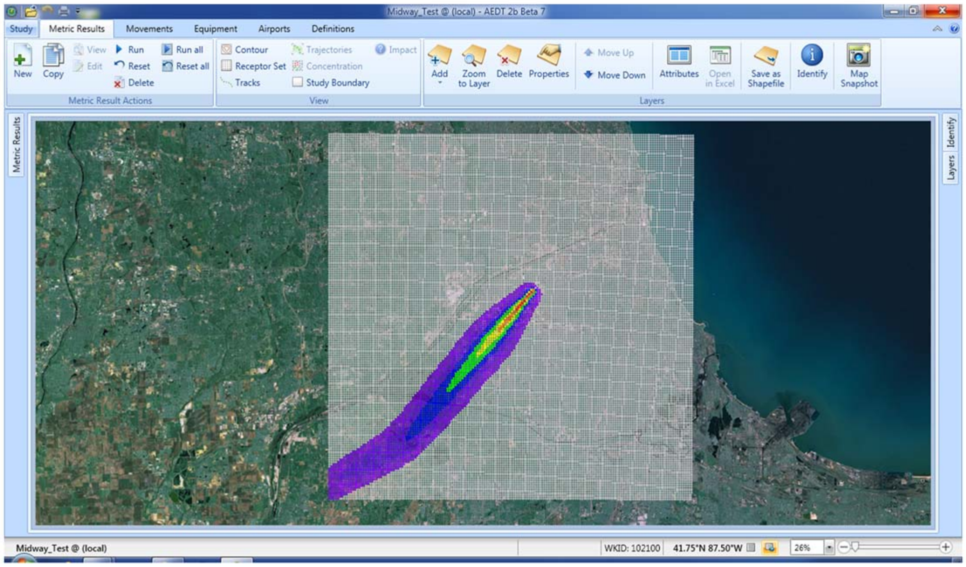
- The fictional green profile has two “At” altitude controls of 5,000 feet, representing an altitude hold near the airport.

Altitude controls

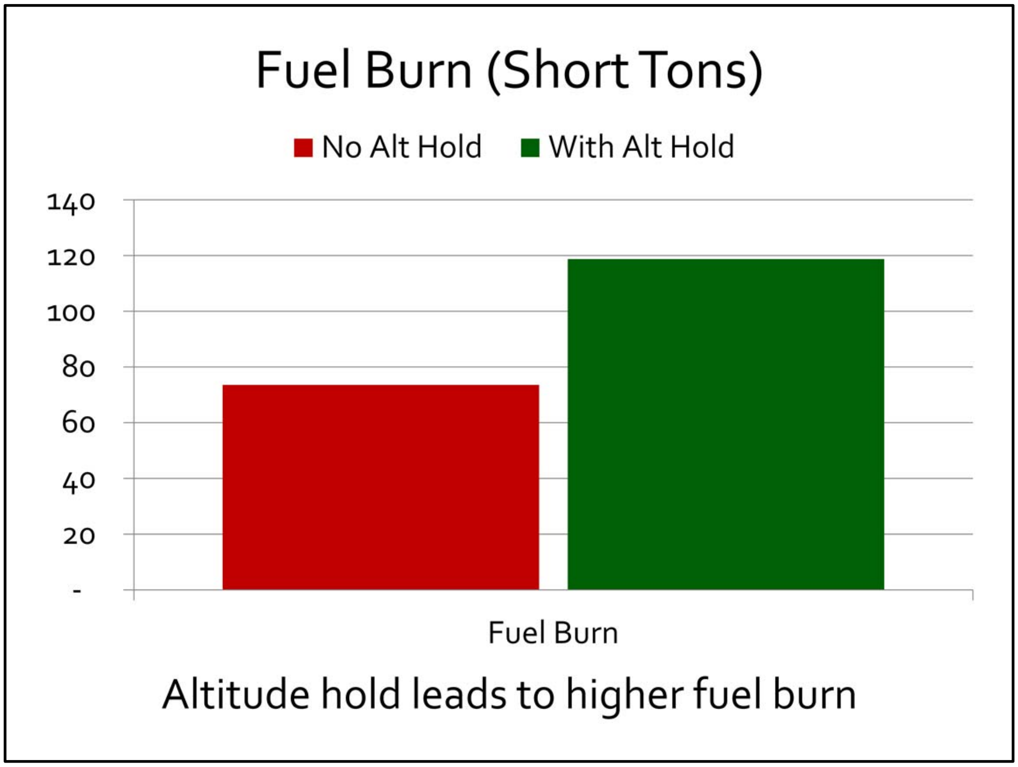


- 300 fictional flights flying in the daytime along the green trajectory (with altitude hold) give the colored noise receptor grid shown here.
    - Purple colors: lower noise
    - Red colors: higher noise

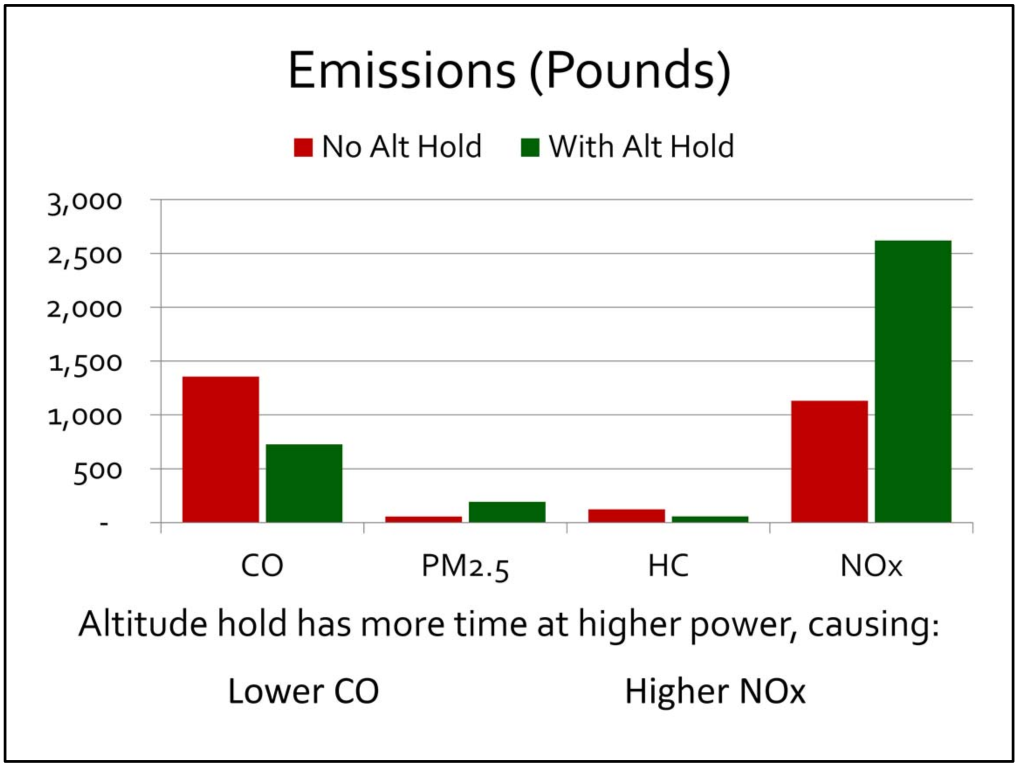
Altitude controls



- Compared with the fictional red trajectory (no altitude hold -- shown here), the fictional green trajectory (with altitude hold) has different noise levels.
  - Purple colors: lower noise
  - Red colors: higher noise



- Fictional fuel burn from profile start (16,000 feet) to landing roll
- 300 fictional flights on the red (no altitude hold) trajectory
- 300 fictional flights on the green (with altitude hold) trajectory



- Fictional emissions from profile start (16,000 feet) to landing roll
- 300 fictional flights on the red (no altitude hold) trajectory
- 300 fictional flights on the green (with altitude hold) trajectory


For further information
http://aedt.faa.gov/


A TRIP THROUGH AEDT 2b
(DEMO VIDEO)
http://youtu.be/fI5K2qT4ijs