Analysis & Tool Development

Presented to: REDAC E&E Subcommittee

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Date: September 15, 2021

Federal Aviation Administration

Presentation Outline

- **Data and tools infrastructure development implementation**

- **Tools Development**
 - AEDT
  - Noise Screening
  - EVT

- **ASCENT Projects**

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Importance of supporting FAA's vision on sharing resources

- **FAA polices and infrastructure are focused on sharing**

- **AEE has developed a variety high quality and high fidelity tools and databases**

- **Those resources are used for analysis to support**
  - Internal and external decision making
  - Public communication

- **Agency-wide use of these data and information will improve agency consistency on environmental issues**

- **Consistency is key given the high visibility of these issues**
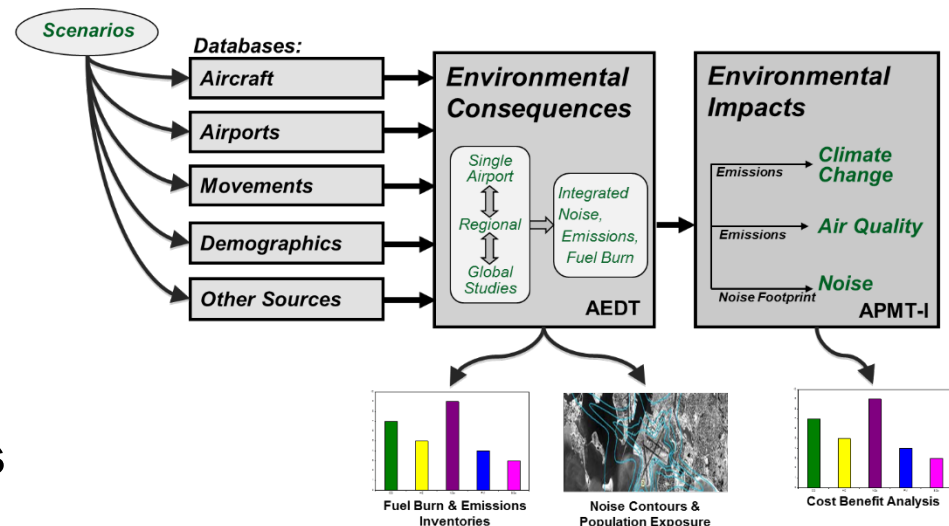
Providing Consistency across the Agency

- Link data processing and warehousing to create a common validated set of data

- Facilitate access to the data

- Support a variety of use cases, and promote consistent presentation

- Integration will benefit the key environmental programs
  - Aviation Environmental Design Tool (AEDT)
  - Environmental Visualization Tool (EVT)
  - Updated Noise Screening Approach
  - Community Outreach

- Consistent and validated data and information will ensure better outcomes for the Agency

Technology Welding and Deployment Plan (TWD)

- **Reference data infrastructure fabrication**
  - Identify authoritative data sources
  - Link authoritative sources and reference databases
  - Automation of updates, validation, and maintenance

- **Data processes infrastructure fabrication**
  - Identify existing processes agency-wide
  - Continue development of AEE's processes
  - Plan the integration into a single system

- **Tools infrastructure fabrication**
  - Ensure all environmental tools are linked to the infrastructure
  - Support linking of other tools (e.g. TARGETS)
  - Provide access through a portal

Integrated infrastructure is to reside on the FAA Enterprise Information Management (EIM) system

Progress toward TWD

- **Reference data infrastructure fabrication**
  - AEDT FLEET database is being moved to the EIM
    - Coordination initiated to add FLEET to the FAA catalog
    - Joining the FAA the EIM Aircraft Stewardship Community of Practice (SCoP) which will provide the FAA wide coordination on authoritative data
  - AEDT NAS-wide inventory data on the EIM: 2019 and 2020
  - Initiated move of LADD* data to the EIM

- **Data processes infrastructure fabrication**
  - Setting up VPC resources to support the FLEET database maintenance processes
  - Established pathway for transferring AEDT-TT[†] data from MITRE to FAA EIM
  - Contracted with FAA Tech Center to established automated sensitive and LADD flights flagging service

- **Tools infrastructure fabrication**
  - NAS-wide noise inventory results on the EIM will provide the baseline data for the updated noise screening methodology
  - EVT successfully migrated to the FAA Cloud Services (FCS) and linked to the EIM ESRI Enterprise service

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AEDT 3d Current Status

- **AEDT 3d released on March 29, 2021**
- **Focus on AEDT maintenance**
- **Usability Improvements**
  - Support for ASIF import of aircraft noise spectral data
  - Statistical compression for time-above metrics
  - Multi-pollutant modeling for emissions inventory and dispersion modeling
  - Re-implementation of SOG emissions generation
  - nvPM computing method update
- **Aircraft Fleet Database Update**
  - nvPM database update for engines with measured data

AEDT 3d Usability Improvements

- **Multi-pollutant modeling for emissions inventory and dispersion modeling**
    - Eliminates runs for each pollutant
    - Same performance model for simultaneous generation of AERMOD input files
    - Reduces time to generate AERMOD emissions dispersion input files
    - Speeds up AERMOD computational time
- **Re-implementation of SOG emissions generation**
    - Workflow changes to save computational time
        - Now applied as a post-processing step
    - Some bug fixes
    - Reduces SOG emissions inventory runtime
    - Speeds up dispersion runtime

AEDT 3d Usability Improvements, cont'd

nvPM computing method update

- **Below the mixing height**
  - Aircraft with measured nvPM EI data
    - Published in ICAO Emissions Databank in December 2020
    - nvPM mass and number determined from mode-specific EI and flight segment fuel flows
  - Aircraft without measured nvPM data
    - FOA 4 (ICAO Doc. 9889)
    - Mode-specific smoke number (SN) for calculating nvPM mass and number
- **Above mixing height**
  - ICAO CAEP WG3 methodology

nvPM – non-volatile Particulate Matter
ICAO: International Civil Aviation Organization
CAEP: Committee on Aviation Environmental Protection

EI: Emissions Indices
FOA: First Order Approximation
WG: Working Group

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AEDT External Feedback

AEDT User Review Group (URG)

- Second Annual URG Meeting held April 2021
- Group continues to be fully engaged and is providing valuable feedback on AEDT releases
- URG augments system testing of new AEDT features
- Continued focus on usability improvements
  - Allow selected tracks to be edited
    - Significantly reduces time required to edit tracks for large studies
  - Loading operations from csv file
    - Simplifies import of flight tracks and operations
  - Stationary source emissions modeling
    - Reflects latest EPA AP-42 & improvements to User Interface

AEDT External Feedback

AEDT Development Process Improvement

- Goals are to improve:
  - Quality – insure accuracy of results and reduce bugs
  - Productivity – Increase throughput of features
  - Predictability – Maintaining scope and timeline
- Kick-off for development process improvement training held in August 2021.
- Virtual classroom training and real-time coaching will begin in September 2021 and run for approximately six months.
- Process Engineer added to team to facilitate training and mentoring process.

AEDT 3e Development Plan

- **Public release planned for spring 2022**

- **Aircraft Performance**
  - Reconcile APM workflows

- **Emissions & Dispersion Modeling Features**
  - Update to latest AERMOD/AERMET version
  - AERMOD source characterization
  - Aircraft lead emissions and dispersion modeling
  - Revise stationary source emissions modeling
    - Reflects latest EPA AP-42 & improvements to User Interface

- **Noise Modeling**
  - Mixed ground impedance and terrain modeling (research)

APM: Aircraft Performance Model
AERMOD: American Meteorological Society/Environmental Protection Agency Regulatory Model
AERMET: Meteorological data preprocessor for AERMOD
EPA: Environmental Protection Agency
AP-42: Compilation of Air Pollutant Emissions Factors

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AEDT 3e: Emissions & Dispersion Modeling Features

- **Update to latest AERMOD/AERMET**
  - AERMOD/AERMET Version 21112
  - NO_2 modeling – two new alpha options
  - Alpha low wind modeling options

- **AERMOD source characterization**
  - Short-term improvement to airport air quality analysis
    - Improves hourly modeled NO_2 predictions
  - Model aircraft exhaust emissions as volume sources
   - Both surface and airborne
  - Additional option, not available to the public immediately

AERMOD: American Meteorological Society/Environmental Protection Agency Regulatory Model
AERMET: Meteorological data preprocessor for AERMOD

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AEDT 3e: Emissions & Dispersion Modeling Features, cont'd

- **Lead emissions & dispersion modeling**
  - Designed for fixed-wing piston engines & helicopters
  - Provides lead emissions & dispersion modeling capabilities
    - For all lead emissions generating activities
    - For fuels with different lead content
  - Dispersion modeling
    - Aircraft emissions modeled as a series of volume sources
    - Night time urban boundary layer
    - Wet and dry deposition
  - FAA and EPA to test from regulatory compliance perspective
    - Beta version not available to public and URG

AEDT Future Development Timeline

ACRP 02-52 Noise Modeling of Mixed Ground Surfaces
ACRP 02-79 Aircraft Noise with Terrain and Manmade Structures
ASCENT 19 Development of Aviation AQ Tool for Airport-Specific Impact Assessment: AQ Modeling
ASCENT 45 Takeoff/Climb Analysis to Support AEDT APM Development
ASCENT 46 Surface Analysis to Support AEDT APM Development
ASCENT 54 AEDT Evaluation and Development Support
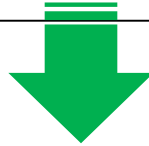
ACRP 02-27 Aircraft Taxi Noise Database
ASCENT 9 Geospatially Driven Noise Estimation Module
ASCENT 10 Aircraft Technology Modeling and Assessment
ASCENT 19 - Development of Aviation AQ Tool for Airport-Specific Impact Assessment: AQ Modeling
ASCENT 40 Quantifying Uncertainties in Predicting Aircraft Noise in Real-world Situations
ASCENT 43 Noise Power Distance Re-Evaluation
ASCENT 54 AEDT Evaluation and Development Support
ASCENT 60 Analytical Methods for Expanding the AEDT Aircraft Fleet Database

2022 | | | | | | **2023** | | | | | | **2024**

- Aircraft lead emissions and dispersion modeling
- Infrastructure and usability updates to improve efficiency and workflow
- Enhance noise modeling for airports near water
- Modeling noise with Terrain and Manmade Structures
- Updated Delay and Sequencing Model
- APM Reconfigure
- Air quality modeling enhancements

- Higher fidelity aircraft noise characterization
- Supersonic Aircraft performance modeling
- Update GIS engine to reduce development costs
- Helicopter noise modeling improvements
- Taxiway Noise
- Updated Standard Profiles
- Updated Fleet Mapping
- New Air Quality model

AEDT 3e

AEDT 4 series – Updates Annually

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Noise Screening Overview

- **Pre-conditioned Flight Track Data**
  - Automation of an AEDT optimized flight track dataset and storage on FAA Enterprise Information Management (EIM) System
  - Validated against all requirements required for public distribution
    - AEE is collaborating with the FAA Technical Center to implement data security filters, but is implementing
    - Providing an interim solution by using statistically aggregated noise inventory inputs

- **Airport specific Noise and Emissions Inventory Datasets**
  - Processing now deployed to AEE's Virtual Private Cloud (VPC)
  - Development of automation tools for Aircraft Fleet Assignments and Flight Track data refinement/management
  - Goal set for quarterly release cycles for CY2022

- **Integrated results data storage and visualization capabilities**
  - EIM data storage and management of noise and emissions results
  - GIS enabled noise screening reports

Proposed Noise Screening Process

Proposed Process

1. Noise inventory results will be used to provide the overall baseline noise exposure conditions : Available in EIM

2. Inputs specific to flight track and operations associated to just the proposed action (before and after action) will be identified and modeled in AEDT through a streamlined process: Limited development required

3. The acoustic difference associated with the change identified in step 2 will be applied to the baseline noise from step 1 to determine the final overall proposed action noise result: Limited development required

4. The specific noise changes determined in step 2 and the final overall proposed action noise results from step 3 will then be visualized through EVT on a noise screening report template: Coordinating with EVT development

- FAA is coordinating internally to inform the format of the noise screening report as well as to identify any tool or analysis gaps

- A validation study will be required prior to final implementation

- Release schedule is TBD, targeting the beginning of FY23 and also seeking coordinating with any required changes needed with FAA Order 1050.1F and the associated desk reference
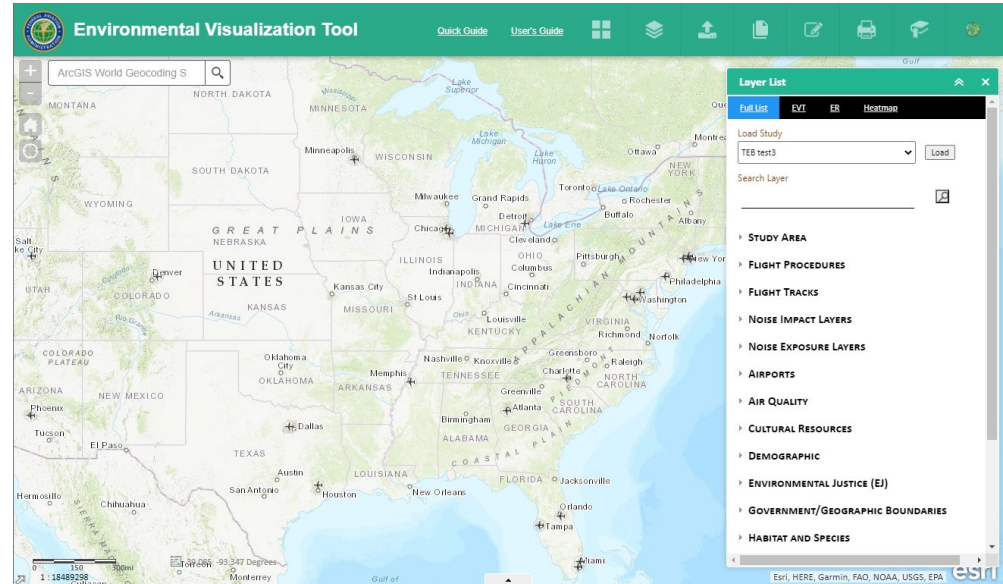
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Environmental Visualization Tool (EVT)

- A Web-mapping application to quickly and easily create customized 2D and 3D maps using uploaded or built-in data layers
- Support Environmental Specialists in viewing and creating customized maps to assess environmental impacts

- Available within the FAA network via a web browser (http://evt.faa.gov/)
- Can help maintain consistency of information and presentation in community outreach activities
- Links to over 100 layers from a variety of authoritative sources
- Allows user-data upload in a variety of formats

EVT Development Updates

- **System Level Updates**
  - Migrated 2D application to the FCS/EIM environment
  - EDT 3D application is under testing by the stakeholder group
  - Still determining if PIV access functionality is available through the EIM infrastructure
  - Planning on establishing a user support/feedback channel
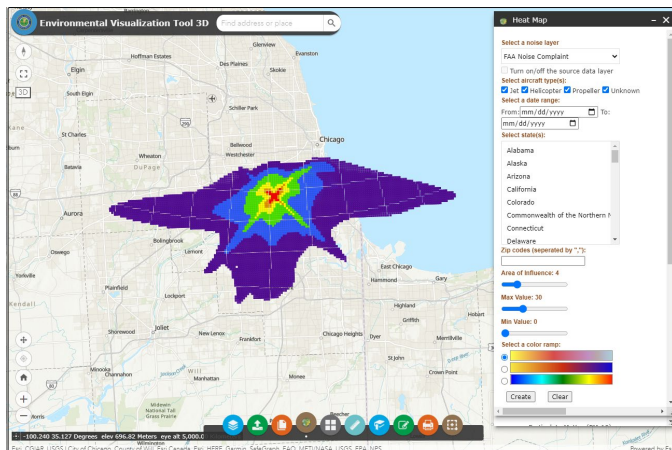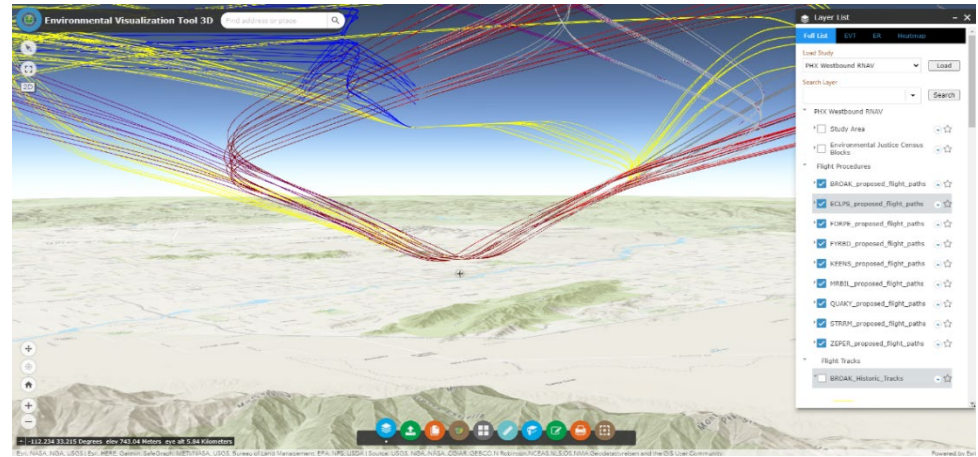
- **Recently released App Functionality**
  - Added Limited English proficiency data upload and display
  - Added 'standard template' layers tab
  - Implemented georeferenced information querying
  - TARGET 3D trajectories upload
  - Implemented Heatmap capability in 3D version

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ASCENT Project 9: Geospatially Driven Noise Estimation Module

Institution: Georgia Institute of Technology
Funding: $250,000/yr. for 3 years

Objective: Develop a novel geospatially driven noise estimation module to support computation of noise resulting from the operation of Unmanned Aircraft Systems (UAS) and other upcoming vehicle concepts.

Approach:
- Leverage emerging computational technologies
- Develop a module that can be connected to other applications
- Concept of precomputed noise grid tiles addition

Expected Impact:
Develop a tool to evaluate noise exposure from UAS/UAM vehicles to provide decision-makers with insight on where the noise might be distributed or concentrated.

Status:
- Coordinated with Assure COE eCommerce projects on input/outputs
- Developed prototype model for eCommerce analysis
- Next steps include model demo for AEE and planning for year 2 development
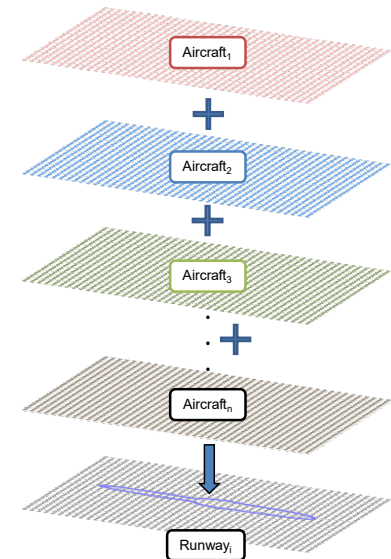
ASCENT Project 53: Validation of Low-Exposure Noise Modeling by Open-Source Data Management and Visualization Systems Integrated with AEDT

Institution: Stanford University

Funding: $400,000/yr. for 4 years

Objective: MONA aims to provide real-time and objective data, analyses, and reports on Metroplex operations. The focus of the first year of this ASCENT project is to improve upon the noise predictions of MONA through tighter integration with AEDT.


Approach:

- Integrate and automate AEDT's noise analysis capabilities to MONA
- Validate and Verify (V&V) AEDT's noise predictions in 55-65 db DNL areas
- Propose software engineering/architectural choices for AEDT v5 to enhance usability

Expected Impact: Provide the capability to perform timely complex noise analyses in metroplexes with the development of a validated data science scalable infrastructure that can serve very large analyses and impact analyses. Apply the capability to develop a proposal for approach routes into SFO (focusing on the SERFR, BDGA, and PIRAT routes) that have the potential to reduce noise impacts on the overflown public.

Status:

- Have deployed a cloud based automated run environment feeding ADS-B generated flight track inputs to AEDT
- Comparing measured vs. modeled noise exposure levels below DNL 65dB to quantify reasons for differences
- Seeking to expand noise monitor network through use of additional ADS-B receivers and coordination with local area airport noise monitor systems.
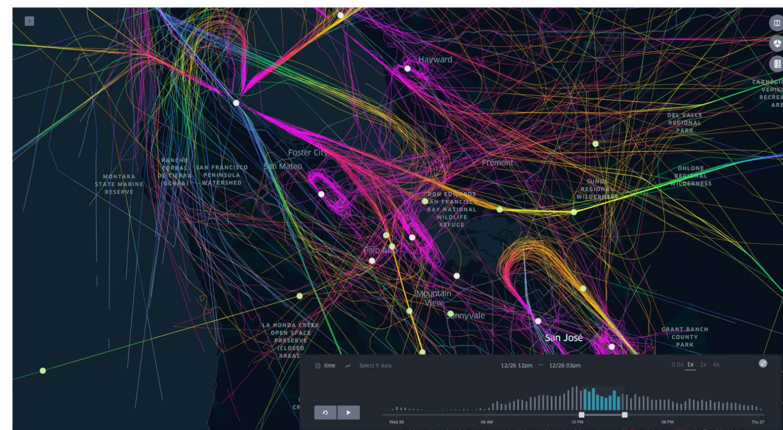
ASCENT Project 54: AEDT Evaluation and Development Support

Institution: Georgia Institute of Technology
Funding: $700,000/yr. for 3 years

Objective: Provide data and methods to continue to improve the aircraft weight, takeoff thrust, and departure and arrival procedure modeling capabilities within the FAA's Aviation Environmental Design Tool (AEDT).

Approach:
- Improve AEDT modeling assumptions through the use of industry and airport flight operational data
- Utilize real-world data flight and noise monitoring data to improve departure, full flight, and arrival modeling
- Evaluate and assess AEDT's software releases

Expected Impact: Improve AEDT's accuracy by modernizing its departure profiles and arrival procedures to reflect current airport operations and enroute modeling and by providing recommendations for enhancements to the AEDT APM*.

Status:
- Working on recommendations for standard approach profiles.
- Continuing to provide critical system level testing of new AEDT features
- Working on Initial draft of AEDT 3 series V&V documentation
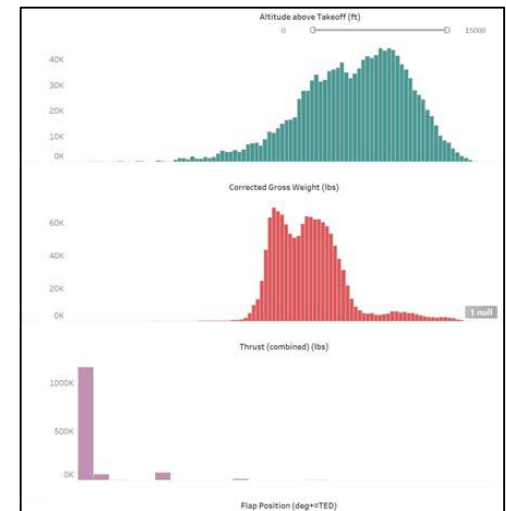
* APM: Aircraft Performance Module

ASCENT Project 60: Analytical Methods for Expanding the AEDT Aircraft Fleet Database

Institution: Georgia Institute of Technology
Funding: $150,000/yr. for 3 years

Objective: improve the accuracy of Aviation Environmental Design Tool (AEDT) noise and emissions modeling of aircraft not currently in the Aircraft Noise and Performance (ANP) database.

Approach:

- Study the characteristics of the aircraft currently missing from the AEDT database and identify distinct types
- Use quantitative and qualitative analytical methods to develop the aircraft ANP and noise data and validate them against flight data and physics-based modeling data
- Develop recommendations and guidelines for how to implement the developed data in AEDT

Expected Impact: Enhance AEDT's environmental modeling accuracy by expanding the AEDT FLEET database to include the noise and performance data of aircraft types that are currently missing

Status:

- Working on clustering methods for identifying best representative vehicles for modeling these aircraft.
- Studying how to conduct feature selection simultaneously for all environmental impact metrics

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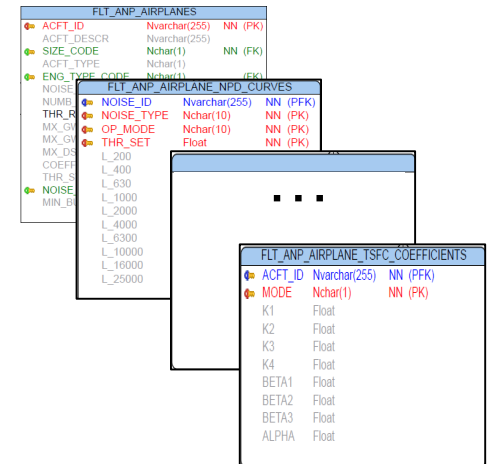
ASCENT Project 62: Noise Model Validation for AEDT

Institution: Georgia Institute of Technology & Pennsylvania State University

Funding: $350,000

Objective: This project focus is to assess the accuracy of AEDT in estimating noise in both the vicinity of airports as well as further afield.

Approach:

- Quantify the new noise modeling capabilities based on comparison to field measurement data from DIA and other airport monitoring systems.
- Include in the validation the effects of noise propagation, ground terrain, and meteorological conditions using data from low-earth-orbit satellites.
- Combine the DIA results with those from the prior validation and verification of the Integrated Noise Modeling (INM)

Expected Impact: Provide a noise model validation benchmark that can be used not only to respond to questions on AEDT noise prediction accuracy, but also to allow the tool development team to prioritize further development of modeling features and enhancements that will improve the predictive capability with respect to real world measurement data.

Status:

- Compared AEDT prediction at multiple noise monitors at San Francisco International Airport
- Used fight trajectory, light data recorder data, and detailed weather data in the modeling
- Conducted preliminary comparison with the noise data, and analyzed elements that contributed to the model-measurement comparison.

Trajectory — Flight: GT 1043 — KSFO

Noise Monitors Triggered — KSFO