ASCENT Project 62

Noise Model Validation for AEDT

Georgia Institute of Technology

PIs: Dimitri Mavris, Michelle Kirby

PM: Bill He

Cost Share Partner: Delta Air Lines

Pennsylvania State University

PI: Victor Sparrow

PM: Bill He

Cost Share Partner: Spire Global

Objective:

- Assess the accuracy of AEDT in estimating noise compared to real-world measurements in both the vicinity of airports as well as further afield under various modeling assumptions
- Enable incorporation of high-fidelity weather in AEDT noise modeling for real-world flights

Project Benefits:

- One of the main benefits of this project is to suggest possible improvements that could be made in future releases that enhance the predictive capability with respect to real world measurement data

Research Approach:

- Using real-world data (flight data, noise monitoring data, high-fidelity weather) identify the various modeling options available in AEDT
- Develop capabilities to automatically model real-world flights in AEDT (using high-fidelity weather information where possible) and compare outputs against noise measurements from corresponding events
- Identify discrepancies, quantify differences, and document possible improvements for future efforts

Major Accomplishments (to date):

- Developed automation scripts that enable modeling real-world flight operations at any desired settings in AEDT
- Developed a new workflow to process and utilize high-fidelity weather in AEDT modeling and demonstrated on sample flights

Future Work / Schedule:

- Model selected flights that span a broad range of operational scenarios
- Improve existing workflow for high-fidelity weather modeling to demonstrate on new flights

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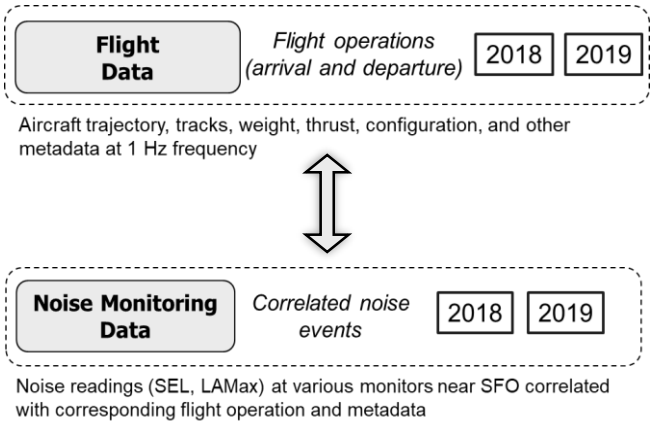
Noise Model Validation Using Real-World Data

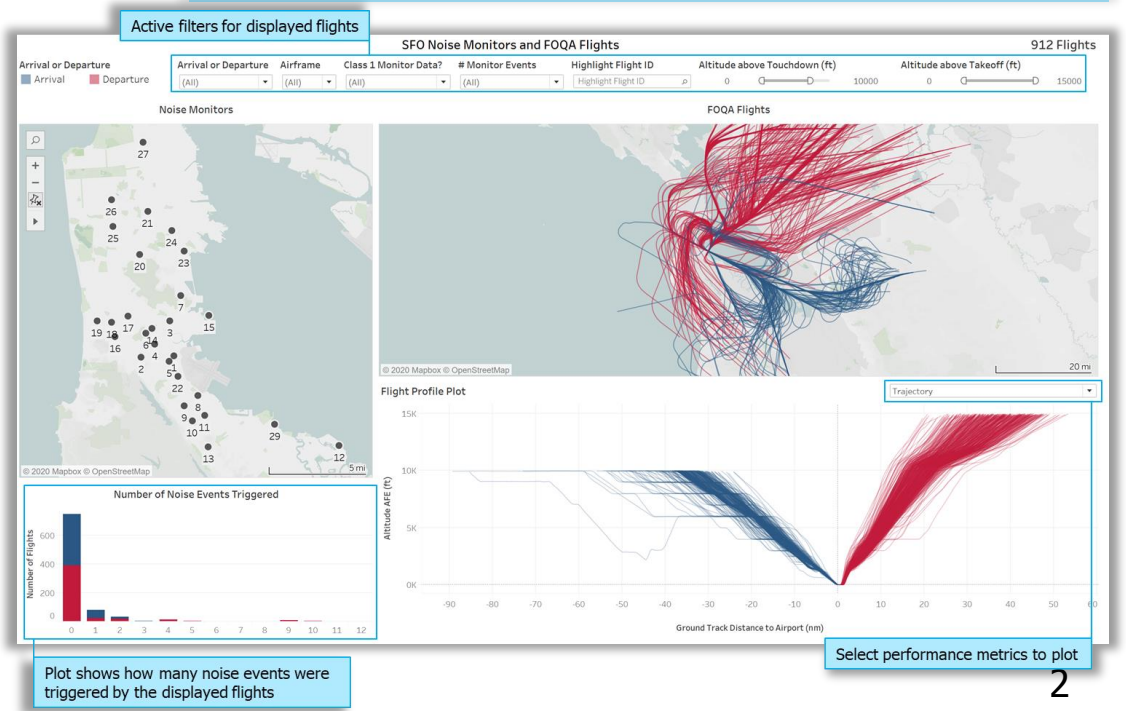
Objective: Assess the accuracy of AEDT in estimating noise compared to real-world measurements in both the vicinity of airports as well as further afield under various modeling assumptions

Methodology:

- ❑ Determination of different modeling options to model real-world flights within AEDT with **compatible** settings
- ❑ Development of **capability to automate** AEDT studies for combinations of modeled settings for departure and arrival for determining their effect on noise prediction
- ❑ Development of scripts to **match available flight data** with corresponding noise monitoring data
- ❑ Model each flight and **observe differences** between AEDT results and real-world operations



Interactive dashboard tool developed to visualize and down-select operations to model in AEDT based on several factors



Test Matrix for Departure and Arrival

Departure

Assumption	AEDT Default	Option 2	Option 3	Option 4	Option 5
Thrust	Full	RT15	FOQA	*RT5*	*RT10*
Weight	AEDT	Alt Weight	FOQA		
Ground Track	Airport Default	FOQA			
Procedure	STANDARD	NADP1_1	NADP2_11	FOQA	
Weather	AEDT Standard	FOQA	High-Fidelity		
Surface	Soft	Hard			
Terrain	None	*Actual*			
Flaps	AEDT	*FOQA*			
Gear	AEDT	*FOQA*			
NPD	AEDT	*NPD+C Corr Function*			

Arrival

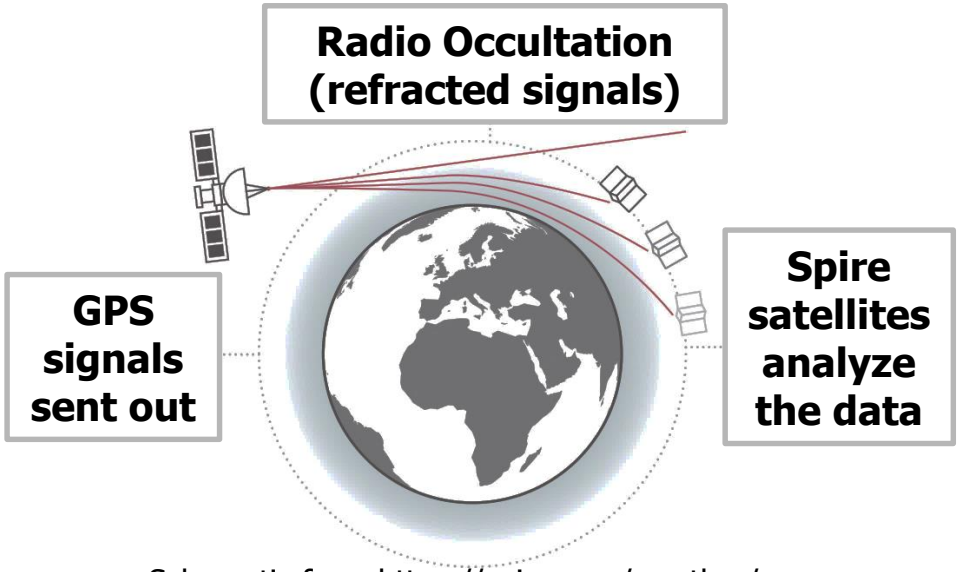
Assumption	AEDT Default	Option 2	Option 3	Option 4	Option 5
Thrust	AEDT	FOQA			
Weight	AEDT	FOQA			
Ground Track	Airport Default	FOQA			
Procedure	STANDARD	FOQA			
Weather	AEDT Standard	FOQA	High-Fidelity		
Surface	Soft	Hard			
Terrain	None	*Actual*			
Flaps	AEDT	*FOQA*			
Gear	AEDT	*FOQA*			
NPD	AEDT	*NPD+C Corr Function*			

- Possible Combinations vary due to fixed point profile and procedural profile capability within AEDT and compatibilities
- Some combinations / settings currently not possible to model in AEDT (e.g., hard v/s soft surface)
- Test matrices coupled with automation scripts allow for modeling of large number of real-world operations

Note: FOQA = Flight Operations Quality Assurance data, i.e., data obtained from quick access recorder on flights

Penn State's role and collaboration with Spire Global [spire.com]

- Include **detailed meteorological profiles** (such as temperature, humidity, wind) to correctly account for the acoustic refraction and absorption in **noise model validation.**
- **Challenge (overcome by collaborating with Spire):** Knowing the state of atmosphere during field tests used for validating aircraft noise prediction tools.



Schematic from https://spire.com/weather/

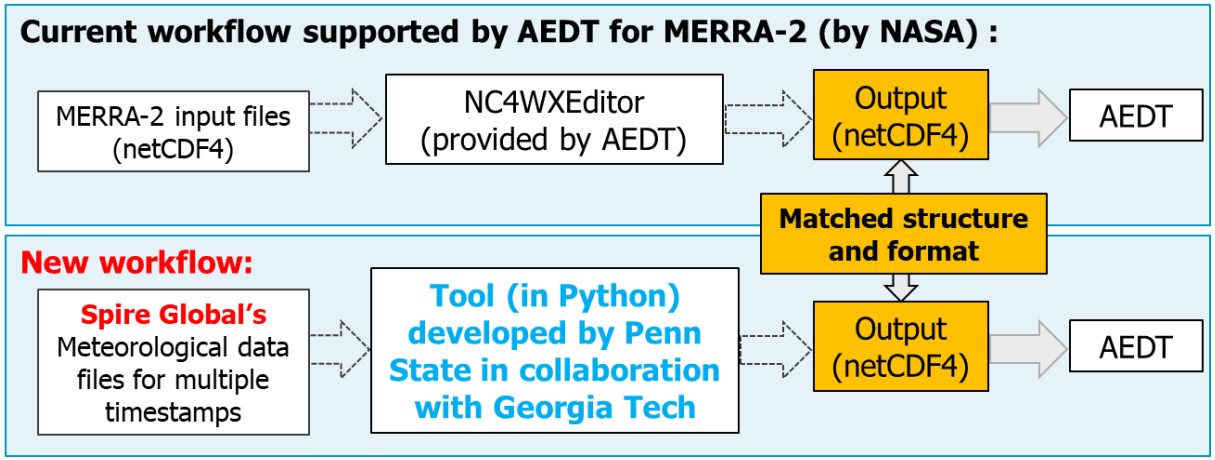
Spire Global has launched a fleet of low earth orbit satellites that will provide **virtual soundings of the atmosphere**

- **Spatial resolution:** 1 km by 1 km grid parallel to the ground, vertical resolution of 500 m.
- **Temporal resolution:** Data available for every hour.

- AEDT can ingest 4D (space and time) meteorological data but requires the data in a very specific structure and format and can use it only for some parts of the modeling.
- Penn State and Georgia Tech worked collaboratively developing a tool **to enhance high fidelity meteorological data for use in AEDT.**

Incorporating High Fidelity Weather in the Modeling Workflow

- Collaboration between GT and PSU has allowed the research team to create a new workflow for preprocessing and ingesting high fidelity MERRA-2 weather data in the modeling process
- Demonstrated the new workflow on sample flight event



Key findings and observations:

- Using our workflow, we were able to obtain differences between modeled noise using airport standard weather and high-fidelity weather
- Noise propagation calculations **do not use** high fidelity weather directly
  - High fidelity weather affects performance results modeled which affects noise levels calculated
- In some operations modeled, multiple days of weather data are needed (overnight flights). Boundary of weather data must encompass total flight trajectory
- 2D MERRA-2 data is not used by AEDT calculations for performance and therefore noise as well even though it is provided

Performance Model	Aircraft Performance	Noise	Emissions
ANP/BADA 3	Input weather data	Airport weather data or ISA with an 8 knot headwind and 60% relative humidity if ISA is selected	Input temperature and pressure, airport weather data or ISA with an 8 knot headwind and 60% relative humidity if ISA is selected for everything else, from the performance event result
ANP/BADA 4	Input weather data	Airport weather data or ISA with an 8 knot headwind and 60% relative humidity if ISA is selected	Input weather data from the performance event result

Source: AEDT Technical Manual

The progress made over the year has unlocked several avenues that the team is pursuing to suggest possible improvements that could be made in future releases