Parametric Uncertainty Assessment for AEDT

Project 36

Project manager: Dr. Mohammed Majeed, FAA
Lead investigator: Dimitri Mavris, Georgia Institute of Technology

Presented by Dr. Dongwook Lim

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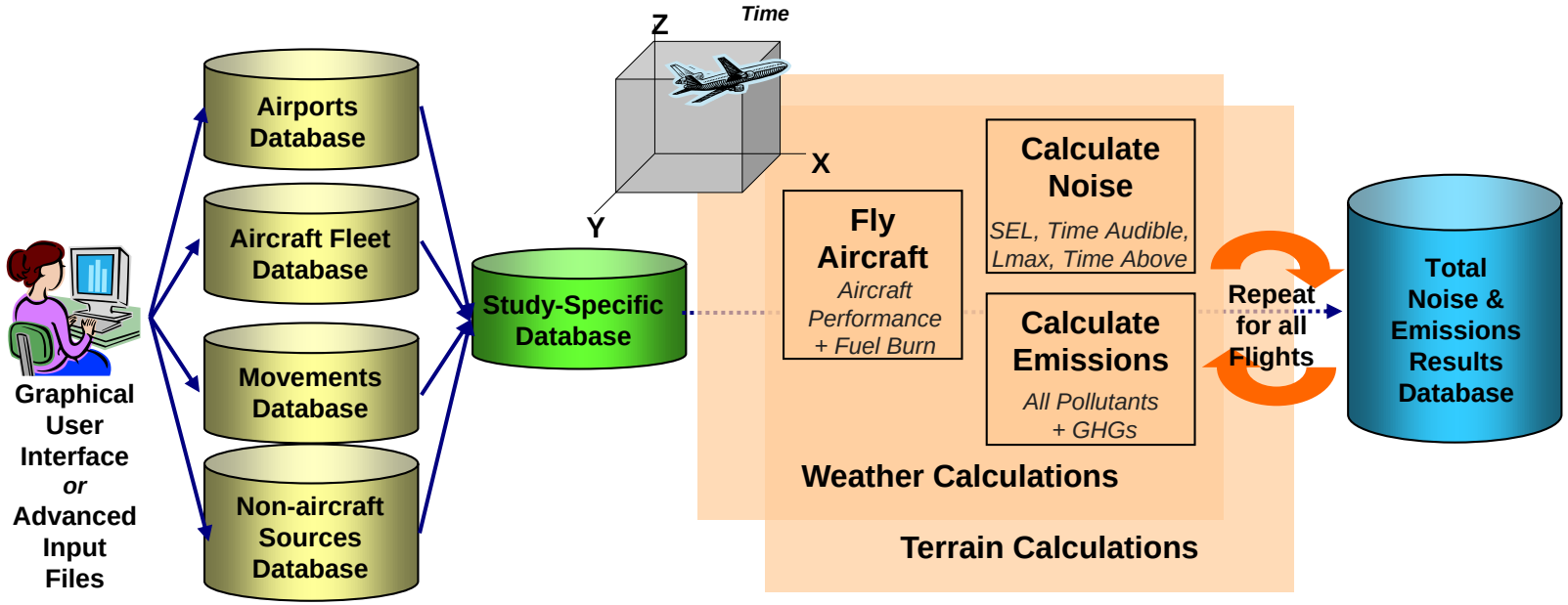
Motivation

- AEDT is in the heart of the FAA/AEE's environmental tool suites for assessing fleet wide fuel burn, emissions, and noise impacts
- AEDT has been used in a number of global and US policy making processes including ICAO NOx, Noise, and CO_2 standard
- As AEDT sets the global standard for environmental impact analysis, it is under continuous improvements to implement the best modeling methods and data
- ASCENT Project 36 is to provide V&V of current and future AEDT versions



Objectives

- Long-term
  - Contribute to the external understanding of AEDT
  - Build confidence in AEDT's capability and fidelity (ability to represent reality)
  - Help users of AEDT to understand sensitivities of output response to variation in input parameters/assumptions
  - Identify gaps in functionality
  - Identify high-priority areas for further research and development
- Near term
  - Perform V&V for new methods and functionalities implemented to AEDT sprint releases
  - Perform capability demonstrations
  - Perform a system level parametric uncertainty/sensitivity analysis

Schedule and Status

Agile Development

Source: http://www.screenmedia.co.uk

Dates	Milestones
May 2016	Project Start (Year 2)
June 2016	AEDT 2b SP3 Release
Sep 2016	AEDT 2c Release
Dec 2016	AEDT 2c SP1 Release
Mar 2017	**AEDT 2c SP2 Release**
Sep 2017	AEDT 2d Release

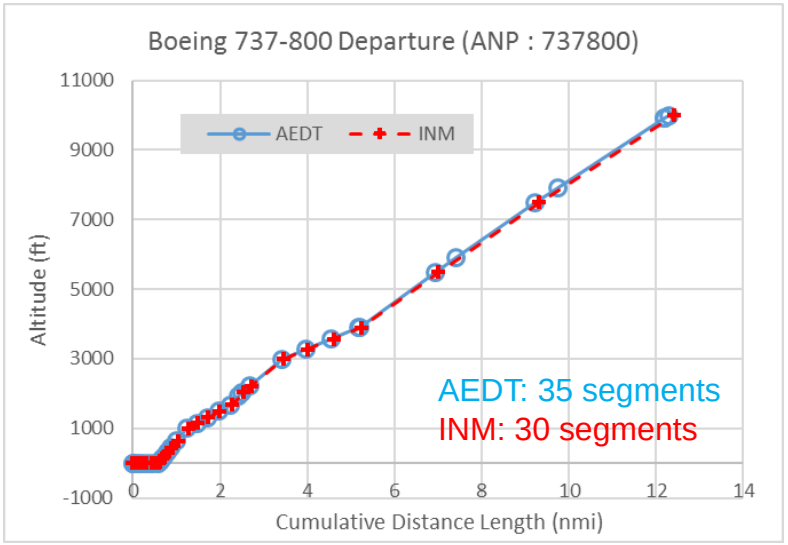
- **Other Tests**
  - Noise comparison between INM and AEDT
  - Fuel burn, emission inventory, and emission dispersion comparison between EDMS and AEDT
  - BADA4 implementation for sensor-path
- **Tests on New Functionalities**
  - Dynamic grid for non-dB metrics
  - Roadway network designer in AEDT GUI
  - Bulk create of operations
  - Detailed noise report
  - Emission dispersion open contour

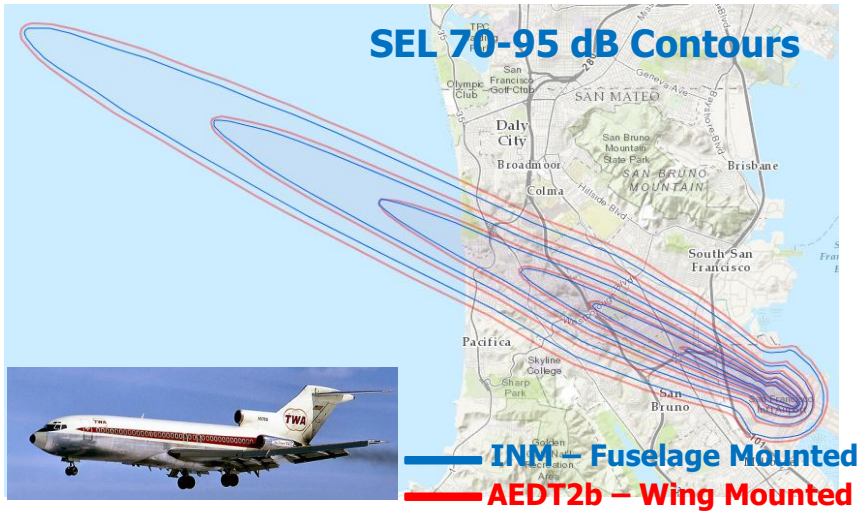
INM vs AEDT - Noise Comparison

- Since AEDT officially replaced INM, it is important to understand the differences between them
- Part 150 type airport noise studies were conducted at a couple of airports in INM and AEDT
- **AEDT 2d and INM generate very similar noise results (less than 1% difference in DNL areas)**
- Prior to AEDT 2d, INM and AEDT could have generated different noise results due to:
  - An error in AEDT's contouring algorithm for complex contour shapes
  - Differences in engine installation location
  - Updates to NPDs (BR710 and O470R)
  - Airport Weather (Standard vs Airport Specific Weather)
  - APM improvements

Main effects

Minor effects





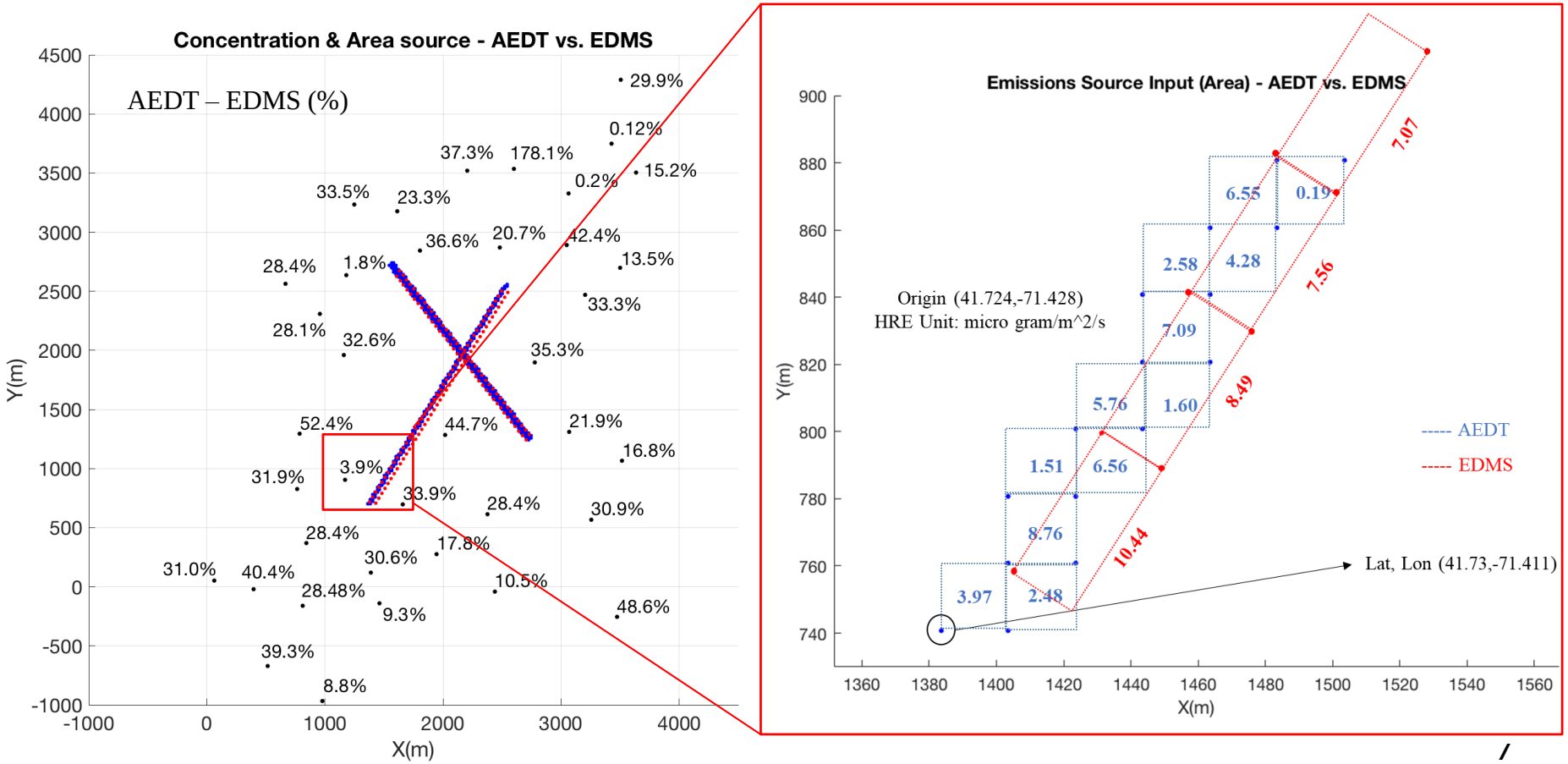
EDMS vs AEDT2b - Emissions Inventory

- AEDT has replaced EDMS for emission inventory and air quality analysis, and it is important to understand the differences between these tools
- The following enhancements to AEDT 2b can result in differences in fuel burn and emissions compared to EDMS:
  - **Engine Emission Databank (EDB) coefficients:** AEDT's emission indices (EIs) are the most current and accurate data available
  - **Fuel burn and emissions calculation methods:** AEDT uses a specialized set of fuel consumption methods that are more accurate than the older methods and data in EDMS. The more up-to-date method and data utilized in AEDT are based upon analysis of flight recorder data obtained from actual flights.
  - **Airport Weather:** The default airport weather in AEDT and EDMS are slightly different. The difference in fuel burn and emissions between AEDT and EDMS can be reduced if consistent weather is used (~2% in this case)

Fuel Burn/Emissions	AEDT 2b	EDMS
Fuel Burn	Senzig-Fleming-Iovinelli (SFI) BADA fuel burn model BFFM2	BFFM2
NOx, HC, and CO	BFFM2	BFFM2
PM	FOA 3.0 FOA 3a (not available since 2b SP3)	FOA 3.0 - Non-US airport FOA 3a - US airport
SOx, CO2	Fuel composition-based factors	Fuel composition-based factors
NMHC, VOC, TOG	Derivative factors	Derivative factors

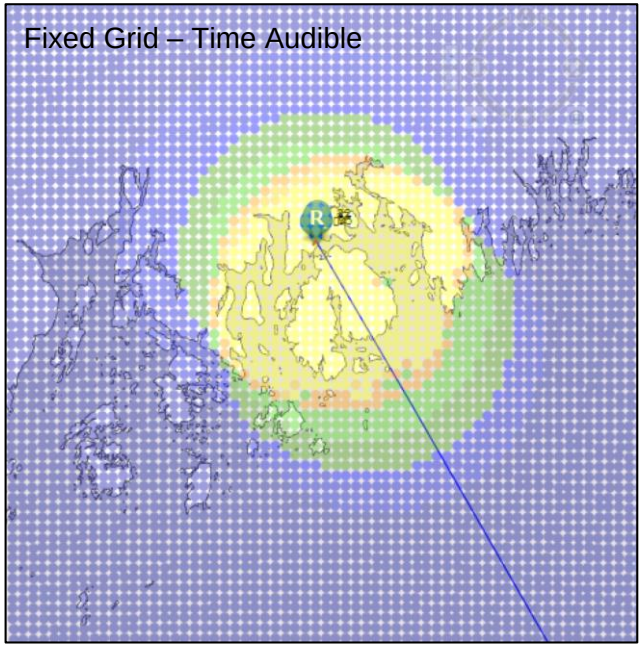
EDMS vs AEDT2b – Emission Dispersion

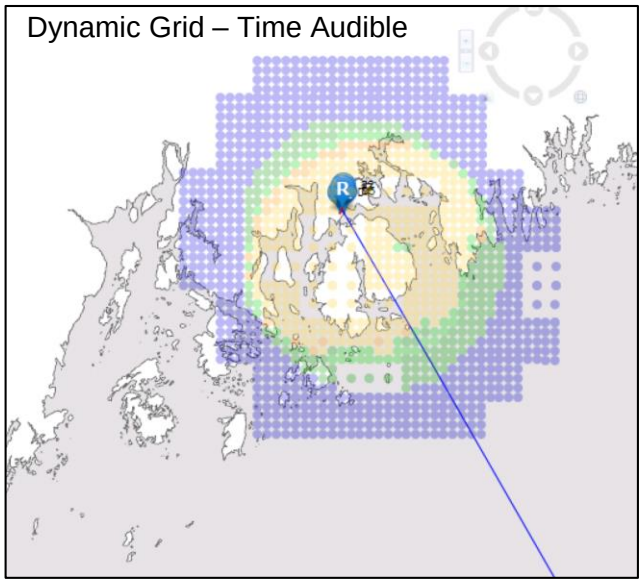
- The difference in some pollutant concentration can be due to:
  - **Flight track:** AEDT and EDMS can have different flight tracks even when an EDMS study is imported into AEDT
  - **Aircraft operations:** When the operational profile is used, AEDT can generate a different pseudo-schedule from EDMS
  - **Area source:** The area sources used by AEDT and EDMS are different
  - **AERMOD version:** AEDT2b uses a more updated version of AERMOD than EDMS



Dynamic Grid for Non-dB Noise Metrics

- Dynamic grid method starts with small grids and expands outward until the desired contour level is closed, which is designed for saving run time
- **Improvements to AEDT:** In AEDT 2c SP2, the dynamic grid method was expanded to non-dB noise metrics, e.g. TAUD, TA, and NA metrics
- **UQ Status:** Dynamic grid functionality was tested for different noise metrics
  - dB metrics including SEL and DNL
  - Non-dB metrics including Time Audible, Time Above, Number Above
- **Conclusion:** Dynamic grid is working properly

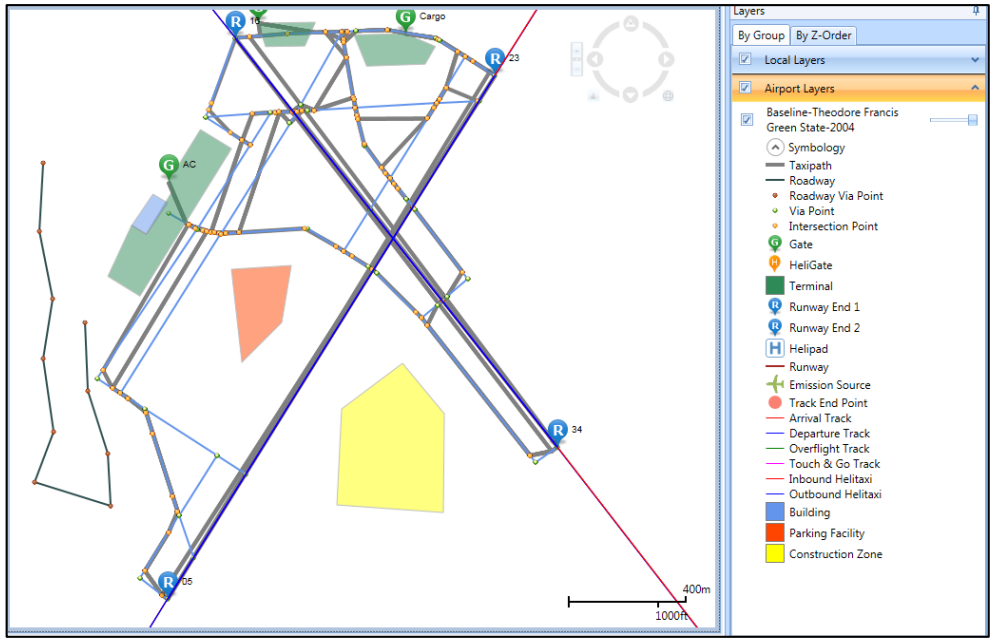




Roadway Network Designer in AEDT GUI

- **Improvements to AEDT**
  - AEDT can import annualized Motor Vehicle Emissions Simulator(MOVES) emissions inventory results by category or annualized link level results
  - MOVES emissions inventory results can be integrated into the VALE report
  - New MOVES links can be added to airport layout
  - The Export MOVES links feature allows for modeling mobile sources in MOVES with inputs exported from AEDT
- **UQ Status**
  - MOVES emissions inventory import functions as intended, including the VALE reporting functionality

AEDT GUI to create MOVES links

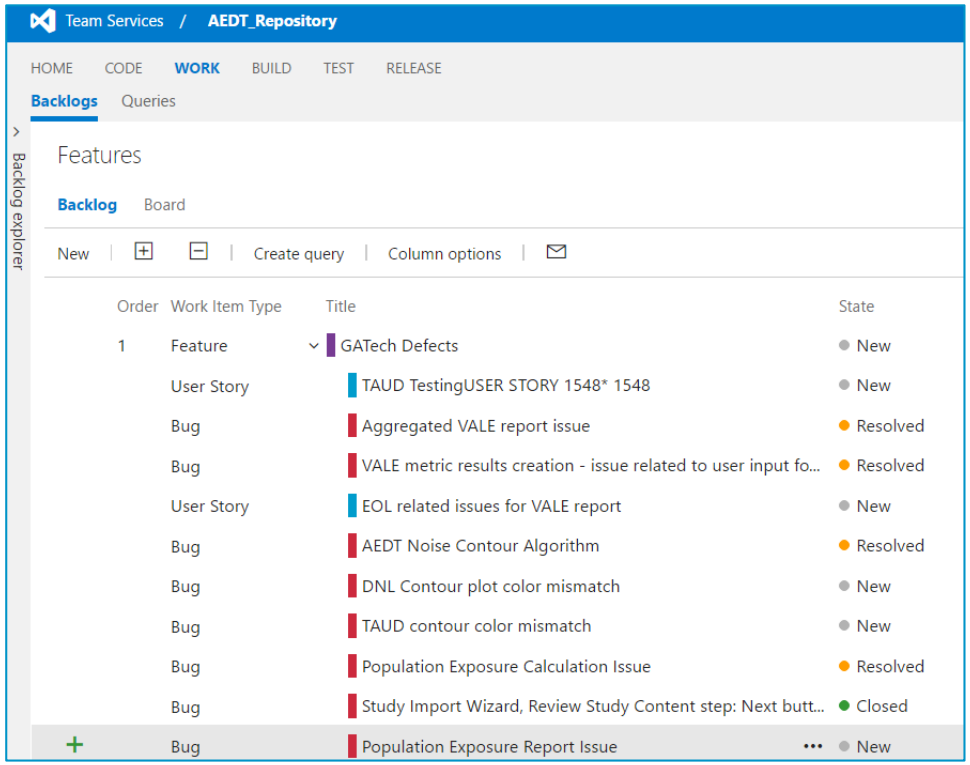


MOVES results are integrated into the VALE report

No.	Year	Scenario	Source Group	CO	VOC	NOx	SOx	PM-10	PM-2.5
1	2004	FlightsFuelTankFourDaysJan2004							
			Roadways (MOVES)	0.010	0.000	0.020	0.030	0.000	0.000
			FlightsFuelTankFourDaysJan2004 Total	**0.010**	**0.000**	**0.020**	**0.030**	**0.000**	**0.000**
		FlightsFuelTankFourDays_Alt							
			Parking (MOVES)	0.210	0.000	0.220	0.230	0.000	0.000
			FlightsFuelTankFourDays_Alt Total	**0.210**	**0.000**	**0.220**	**0.230**	**0.000**	**0.000**
			2004 Net ER	***0.200***	***0.000***	***0.200***	***0.200***	***0.000***	***0.000***
2	2005	FlightsFuelTankFourDaysJan2004							
			Roadways (MOVES)	0.040	0.000	0.050	0.060	0.000	0.000
			FlightsFuelTankFourDaysJan2004 Total	**0.040**	**0.000**	**0.050**	**0.060**	**0.000**	**0.000**
		FlightsFuelTankFourDays_Alt							
			Parking (MOVES)	0.240	0.000	0.260	0.270	0.000	0.000
			FlightsFuelTankFourDays_Alt Total	**0.240**	**0.000**	**0.260**	**0.270**	**0.000**	**0.000**
			2005 Net ER	***0.200***	***0.000***	***0.210***	***0.210***	***0.000***	***0.000***

Interfaces and Communications

- External
  - Weekly telecons with the AEDT development team
  - On-line communication via **Team Foundation Server (TFS)**



- Within ASCENT
  - Bi-weekly telecons with the FAA/AEE
  - P11b, P43, and P45

Summary/Next Steps

- GT team has been working very closely with the AEDT development team to conduct independent V&V of the current and future AEDT versions
- GT has identified some bugs and needs for minor improvements → **Most of them have already been addressed by the development team!**
- Documented the findings on TFS for the developers and AEDT UQ reports for the general public
- The AEDT 2B UQ report has been updated and will be published soon!
- Primary next steps on AEDT 2d tests:
  - Noise grid import and merging
  - Vector track creation and editing
  - Track dispersion modeling
  - Hi-fi weather WRF

References

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Contributors

Prof. Dimitri Mavris, Dr. Michelle Kirby, Dr. Dongwook Lim, Dr. Yongchang Li, Dr. Holger Pfaender, Dr. Mathew Levine, Mr. Junghyun (Andy) Kim, Ms. Evanthia Kallou