Aviation Environmental Design Tool (AEDT)

Continuous Descent Approach (CDA) Modeling Demonstration

Presented to: TRB AEDT/APMT Workshop #4

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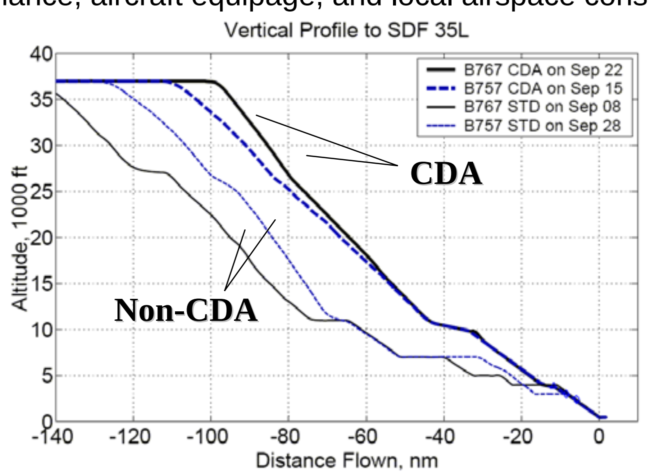
What is a CDA?

- **Continuous Descent Approach (CDA):**
  - An optimized approach procedure where the aircraft descends continually at idle thrust from cruise to landing.
  - Actual procedures and trajectories dependent upon aircraft performance, aircraft equipage, and local airspace considerations



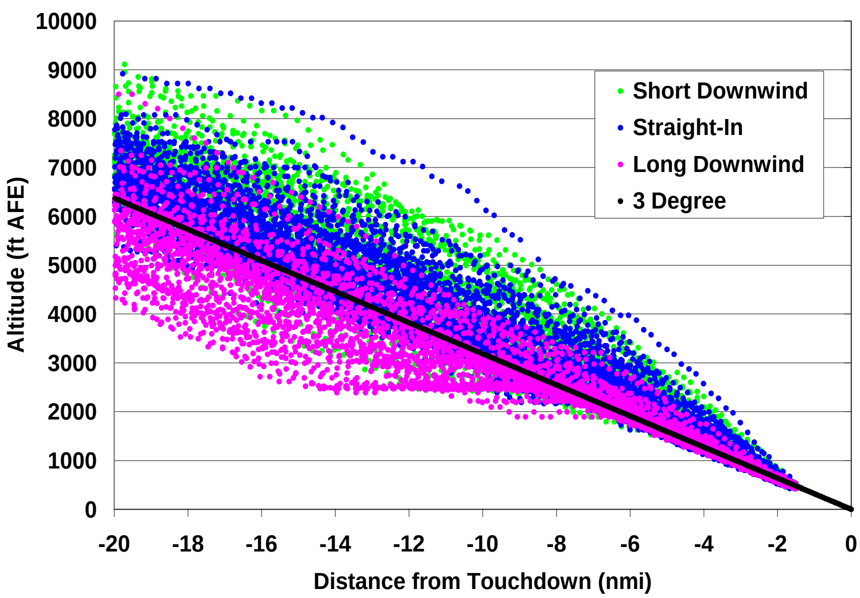
Motivation

- **FAA/PARTNER Center of Excellence sponsors research in Continuous Descent Approach (CDA) Operational Studies:**
  - Quantified Environment Effects in 2002 Flight Test
  - Air Traffic Control Operational Proofing in 2004 Flight Test
  - Demonstrations Identified Reduced Noise, Fuel Burn, Engine Emission and Time savings (Louisville CDA study: Report No. PARTNER-COE-2005-002, January 2006)

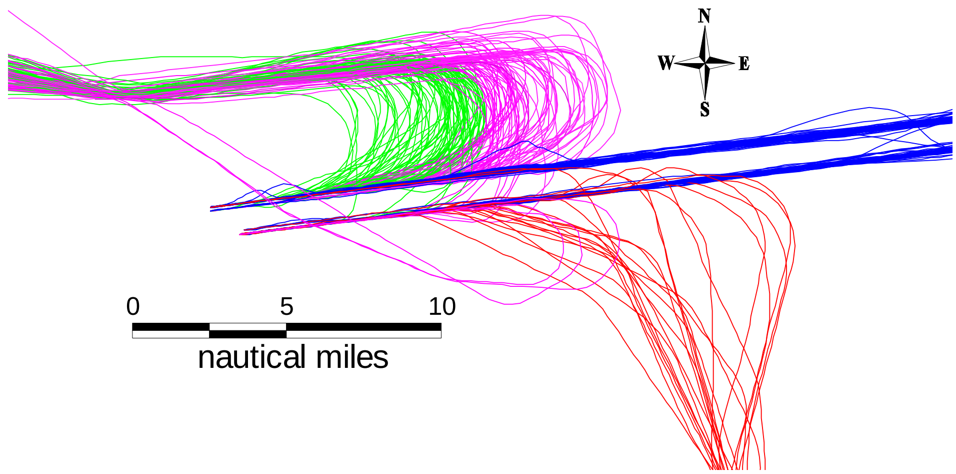
- **Modeling CDA offers an alternative aircraft operational flight procedure for targeted environmental mitigation.**

- **Establishing this capability in AEDT allows for:**
  - modeling real-world, wide-scale environmental benefits
  - projecting cost/benefits of future CDA implementation

Typically Modeled vs. Actual Approach Profiles

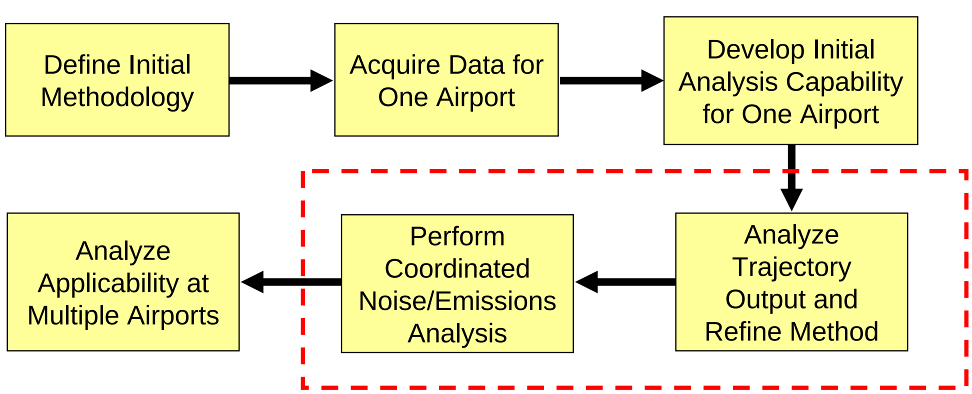


Approach Routes



CDA Demonstration Development

- **Capability Demonstration is still underway:**



Assumptions

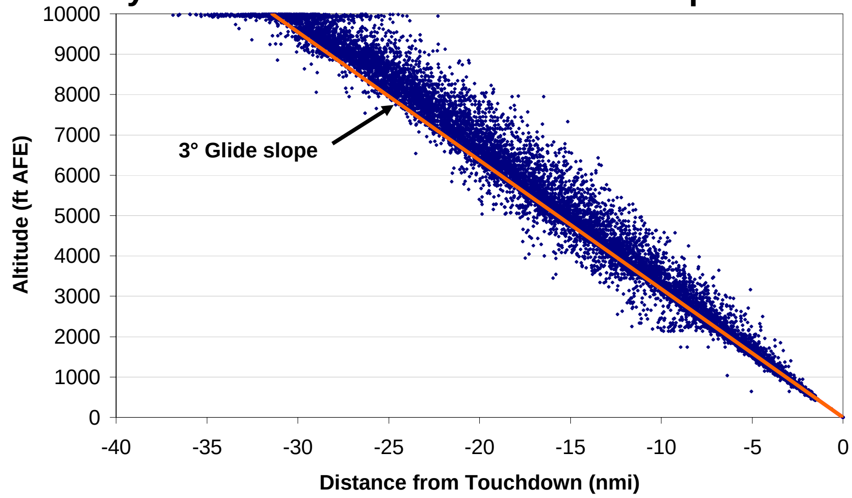
- **Limited initial airport study :**
  - Operations and trajectories derived from 3 days of radar data
  - Only one operating configuration modeled
  - Only Approach operations modeled
  - Hypothetical CDA trajectory assumed
  - Assumed CDAs can be implemented across all approach routes
  - Assumed CDA implementation levels determined by traffic levels
- **Ongoing/future rounds of analyses will include expanded scope**

Baseline Approach Profiles

- **Radar is the best widely available data source for current baseline approach trajectories**
- **Requires derivation of thrust levels in order to be used for environmental modeling**
  - No standardized method exists
  - Requires aircraft performance data that is missing from available databases for several important aircraft
- **Society of Automotive Engineers (SAE) A21 committee has recently formed a Project Working Team to address the issue**
  - Current CDA Demonstration methodology to serve as the basis for guidance document development

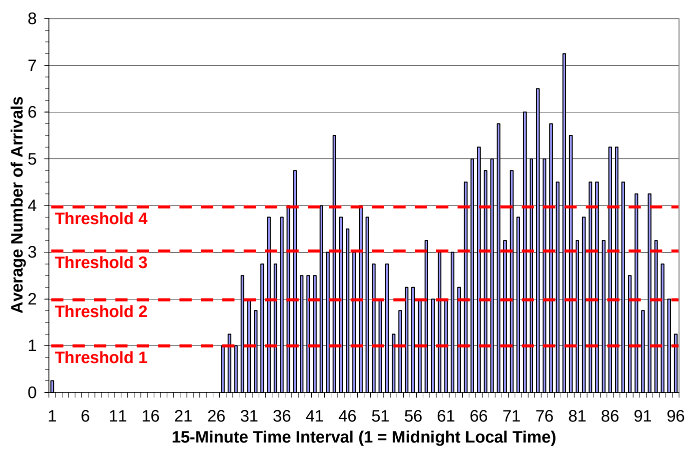
CDA Approach Profiles

- CDAs assumed to follow constant 3-deg glide slope with aircraft type-specific speed schedules observed from Straight-In approaches
- Future analyses will use actual observed CDA profiles



CDA Implementation Levels

- Realistic CDA implementation levels are currently undefined for most airports
- Six scenarios ranging from current baseline to all-CDA operations were modeled using traffic flow thresholds



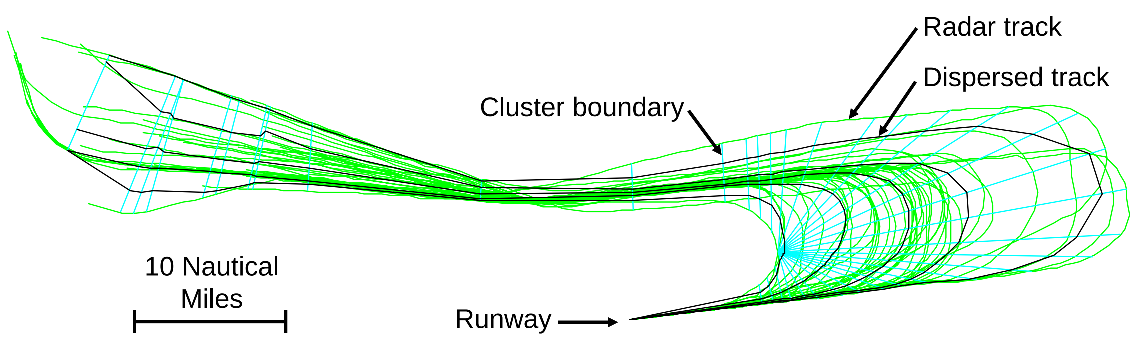
Scenario	Percentage of Operations Flying CDAs
Baseline	0.0
Threshold 1	5.9
Threshold 2	21.0
Threshold 3	42.9
Threshold 4	67.3
All-CDA	100.0

Flight Path Dispersion

- **Goal is to make CDA modeling capability available for Local Legacy analyses**
- **Requiring every actual radar trajectory to define baseline conditions can be impractical**
  – Computationally prohibitive for Local analyses
  – Historical radar data does not allow for projecting flight paths and operational levels into the future
  – Large amounts of high-resolution radar data may not always be available
- **Horizontal and vertical dispersion simplify modeled trajectories and allow profile trends to be projected into the future**

Horizontal Dispersion

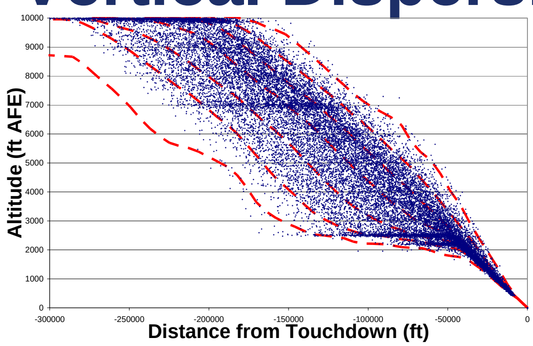
- **Common practice in INM studies**
- **Recommended practice included in ECAC-Doc 29**
- **Automated for AEDT**

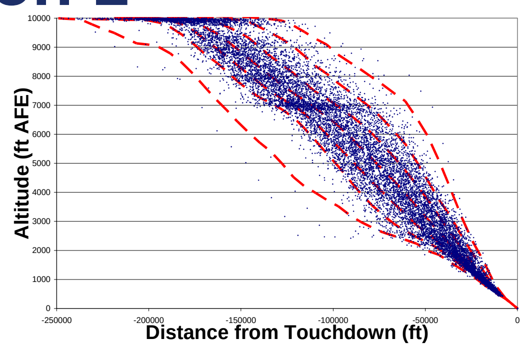


Vertical Dispersion

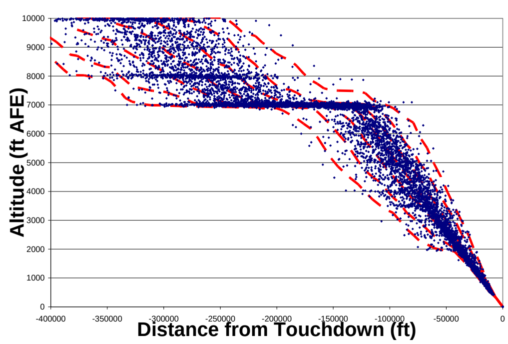
- **More challenging than horizontal dispersion as vertical position trends more heavily impact aircraft thrust, noise, fuel burn and emissions**
- **Difficulty is in simplifying vertical profiles without washing-out key characteristics like level segments**
- **Various automated methods are being created and evaluated for use in baseline modeling**

Vertical Dispersion 1



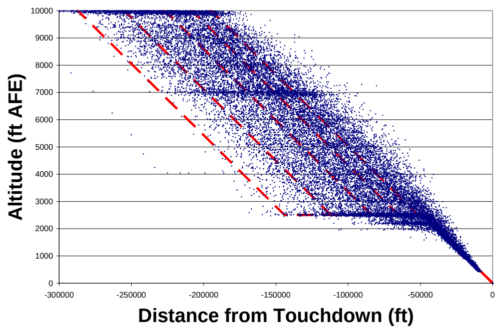


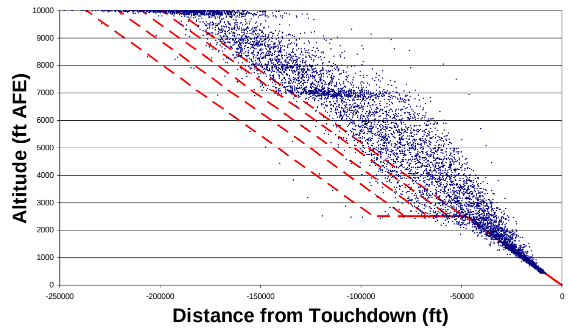
-- 1.56%
-- 9.38%
-- 23.44%
-- 31.24%
-- 23.44%
-- 9.38%
-- 1.56%



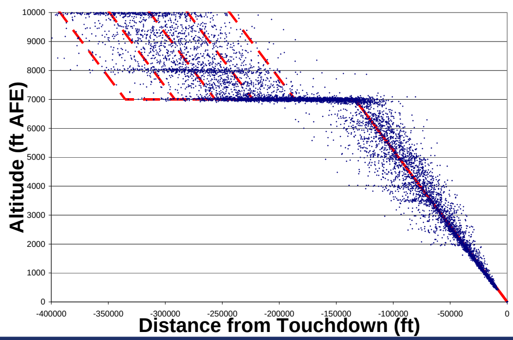
- Average altitude vs. distance per population group
- Smoothes over level segments

Vertical Dispersion 2



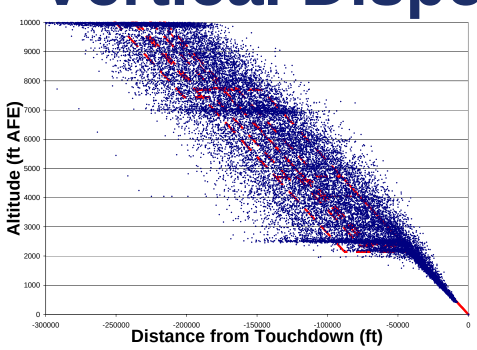


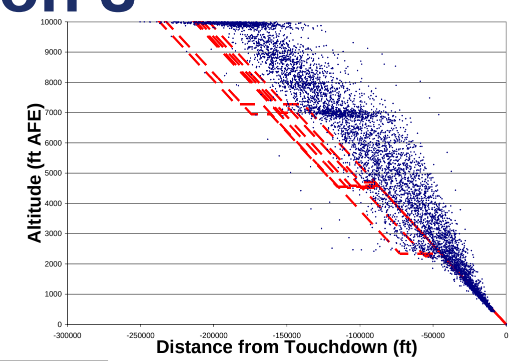
-- 6.50%
-- 24.00%
-- 39.00%
-- 24.00%
-- 6.50%



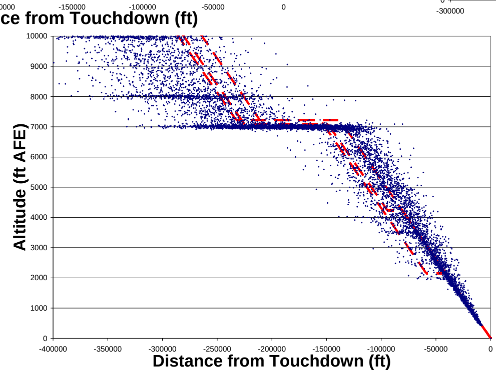
- One level altitude per weight class and route
- Unique level distance per population group
- Total level distance retained but altitude of level segments changed

Vertical Dispersion 3



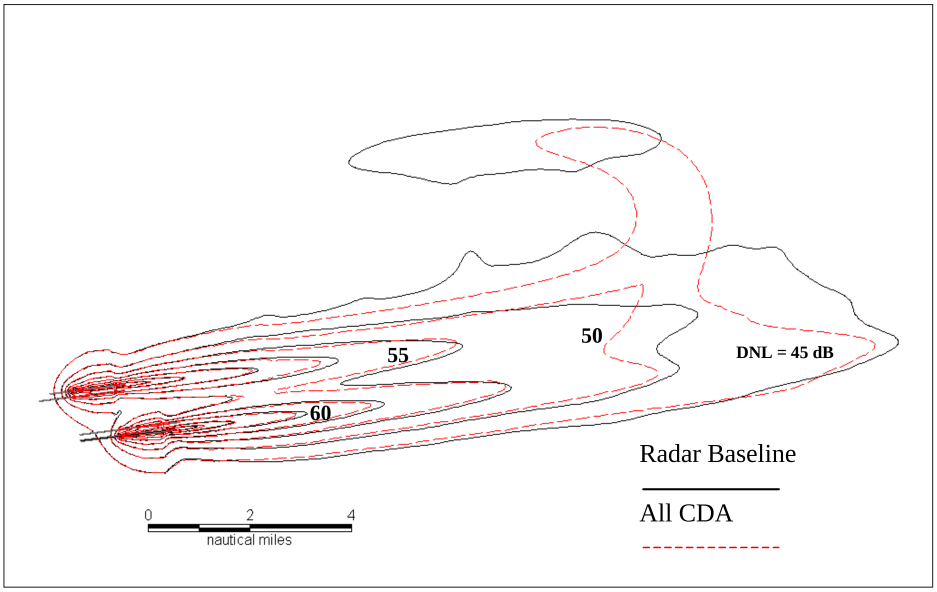


-- % varies by weight class/ route



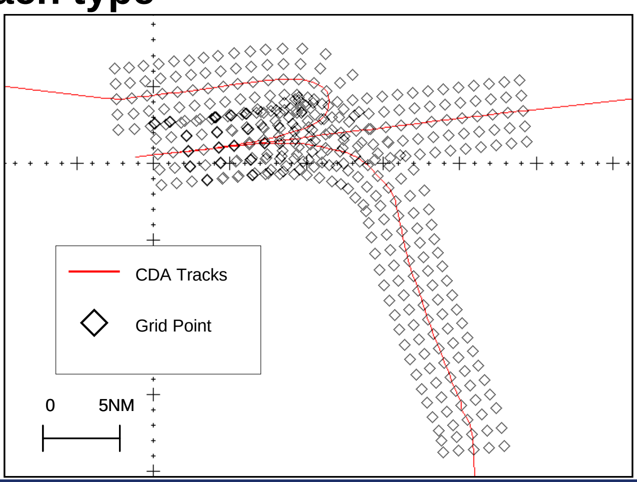
- Binned level altitudes, average level distance
- Total level distance retained, altitude of level segments remains consistent
- Length distribution of level segments lost

Day-Night Average Noise Level (DNL) Contour Impacts

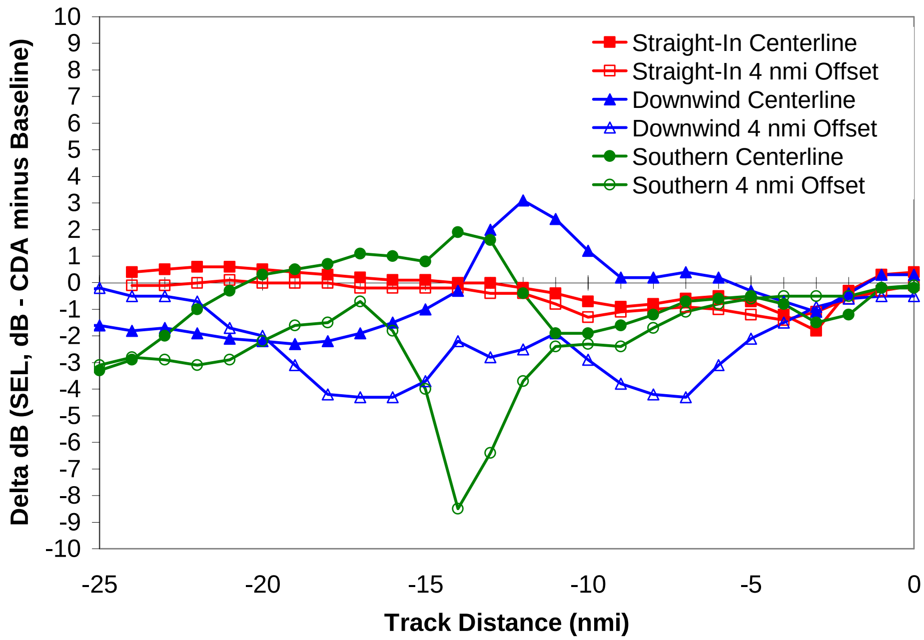


A-Weighted Sound Exposure Level (SEL) Grid Points

- **Grid points can help determine noise impacts of both vertical profile and horizontal track differences per approach type**



SEL Comparisons



Fuel Burn and Emissions

10,000 ft AFE to Touchdown

Emiss	% Change Relative to Baseline		
	Straight-In	Downwind	Southern
CO	-8.7	-13.8	-26.7
THC	-8.8	-11.0	-23.9
NMHC	-8.8	-11.0	-23.9
VOC	-8.8	-11.0	-23.9
NOx	-18.1	-32.3	-51.8
SOx	-14.7	-26.9	-46.1
CO_2	-14.7	-26.9	-46.1
H_2O	-14.7	-26.9	-46.1
Fuel	-14.7	-26.9	-46.1

Verification and Validation

- **Modeling simplifications such as vertical dispersion need to be validated against results using all data at several airports**
- **Methods for calculating thrust from RADAR data can be enhanced and validated using Flight Data Recorder (FDR) information, preliminary efforts have already been completed**
  - Comprehensive FDR data sets are being obtained
  - SAE A-21 PWT efforts will directly support this

Current Limitations

- **Lack of CDA profile definitions**
  - Round 2 analysis currently underway using data observed from actual CDAs at the modeled airport to define flight paths
- **Unknown CDA implementation issues**
  - Changes to the airspace required for CDAs not accounted for
- **Limited operations data set**
  - Round 2 analysis currently underway using a larger radar data set from throughout the year
- **Limited aircraft performance data**
  - EUROCONTROL currently working with Airbus to supply necessary data for entire Airbus fleet, FAA working on additional Boeing data
- **Limited use of wind data**
  - Need to balance accuracy requirements vs. publicly available wind data sources

Context for AEDT

- Baseline and CDA operations definitions and trajectories developed for the CDA Demonstration are usable across AEDT and legacy models
- Methodology applicable to modeling other alternative flight procedures
- Radar analysis capabilities developed for the CDA Demonstration can support PARTNER efforts related to CDA implementation, JPDO efforts, and other AEDT efforts related to operations mitigation
- Automated aircraft identification and horizontal/vertical dispersion methods available for legacy analyses to improve standardization across modelers

Summary

- New modeling methods being developed and applied
  - Methods still being refined and require validation
  - Working in conjunction with technical groups such as SAE A21
- Limited scope analysis completed
  - Limited radar data set
  - Only one operating configuration
  - Only approach operations
- CDA benefits vary greatly across approach routes
- Analysis scope will be increased and repeated at multiple airports

Next Steps

- Obtain and incorporate additional aircraft performance data
- Support development of and incorporate standardized methodology for deriving thrust from aircraft position data
- Develop guidance on appropriate vertical dispersion techniques
- Evaluate CDA Demonstration methodology at a number of airports
- Develop method for concurrent display of noise and emissions results
- Perform significant validation work on any new computational methods developed

??? Questions ???

FAA Environmental Tools web site:

http://www.faa.gov/about/office_org/headquarters_offices/aep/models/