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DETERMINING THE ENVIRONMENTAL BENEFITS OF IMPLEMENTING CONTINUOUS DESCENT APPROACH PROCEDURES

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Abstract

Several research efforts to date have been aimed at demonstrating that Continuous Descent Approach (CDA) procedures have the potential for significant environmental benefits including reductions in noise, emissions, and fuel burn. These efforts typically involve evaluating small numbers of CDA flights under idealized flight test conditions. This paper focuses on the development and application of methods for quantifying potential airport-wide environmental benefits of implementing CDAs. These efforts are being performed as part of the demonstration of a CDA modeling capability within the U.S. Federal Aviation Administration's Aviation Environmental Design Tool (AEDT). Existing internationally accepted modeling methods and data are used, where appropriate, including methods described in the Third Edition of European Civil Aviation Conference (ECAC) Doc 29 and data from EUROCONTROL's Aircraft Noise and Performance (ANP) database. These are used in conjunction with real-world operational and flight procedure data to look at the noise, emissions and fuel burn benefits of CDAs. The benefits are evaluated based on potential future levels of CDA implementation as a function of traffic flow density. This type of analysis may help support Air Traffic Management (ATM) decisions on CDA implementation based on tradeoffs between the efforts required to implement CDAs versus the predicted environmental benefits.

Introduction

Recent studies have shown that Continuous Descent Approach (CDA) procedures have the potential for producing significant reductions to both noise and emissions levels in the vicinity of airports, thereby minimizing or removing capacity restraints due to environmental concerns. Implementing CDAs at a number of airports has become a top priority for several agencies with ATM responsibilities, including the U.S. Federal Aviation Administration (FAA). The capability to model those environmental benefits is needed to support CDA implementation efforts. In addition, methods needed for accurate before and after CDA comparisons will improve the modeling of approach flight profiles for environmental purposes in general and could also be applied to other operations-based environmental mitigation strategies that could be considered by the ATM community.

This paper addresses methods for overcoming current limitations in noise and emissions modeling of approach operations that prevent a meaningful determination of the benefits to be obtained from CDAs or other operational procedures. It also outlines methods for overcoming current limitations related to modeling CDA flight paths themselves. These methods are assessed in an example analysis of the noise, emissions and fuel burn benefits of CDA implementation at a major U.S. airport, based on actual current levels of CDA implementation as well as on potential future levels of implementation as a function of traffic flow density.

Background

The aircraft flight paths currently used during airport noise and emissions analysis are typically generated using guidance from standards documents such as the Society of Automotive Engineers (SAE) Aerospace Information Report (AIR)-1845 or the European Civil Aviation Conference (ECAC) Document 29 [1,2]. These documents describe methods for calculating aircraft flight paths using performance data and flight profiles supplied by aircraft manufacturers. The two main sources for these data accessible by the general public are the standard database from the Federal Aviation Administration's (FAA) Integrated Noise Model (INM) [3], and EUROCONTROL's recently created Aircraft Noise and Performance (ANP) database. The two databases are consistent with each other and conform to SAE-AIR-1845 and ECAC Document 29 guidance. Flight profiles from the INM database are used directly when performing noise analyses with the INM and they are also used when modeling airport emissions using the current version of the FAA's Emissions and Dispersion Modeling System (EDMS).

The INM and ANP databases contain manufacturer-supplied approach and departure profiles for most aircraft in the world's commercial aircraft fleet. These profiles were developed to represent how each aircraft would normally fly at typical commercial airports. There are several profiles defined for departure operations, representing a range of operating weights. For approach operations, however, there is typically only one flight procedure defined per aircraft. Models like the INM allow users to modify the standard flight profiles contained in the database or even create their own profiles, however experience shows that the majority of airport noise and emissions analyses rely on the standard, manufacturer-supplied profiles. Experience also shows that there can be large differences between the manufacturer-supplied approach profiles used for environmental modeling and the approach profiles actually being flown at airports. In fact, the typical manufacturer-supplied approach profiles often closely resemble CDAs and are not suitable for use when trying to generate baseline noise and emissions levels for comparison with those generated by CDAs.

There have been several recent efforts focused on modeling CDAs for a small number of flights. These efforts include the CDA testing and analysis at Louisville International Airport (KSDF) performed by the FAA/NASA/Transport Canada sponsored Partnership for Air Transportation Noise and Emissions Reduction (PARTNER)[4], and EUROCONTROL's Sourdine project[5]. The PARTNER work focused on designing and implementing CDAs, and investigated the noise and emissions benefits from a small number of actual flights following CDA profiles developed specifically for late night operations at KSDF. While this effort did include the implementation of actual CDAs as well as an attempt at quantifying their environmental benefits, it was a limited experiment and further work is needed relative to both the CDA design and environmental modeling aspects of the capability demonstration in order to further CDA implementation. The Sourdine project looked at enhancing the current method of predicting aircraft source noise levels purely as a function of thrust by also considering aircraft configuration and speed. Through the development of configuration-specific Noise-Power-Distance (NPD) curves, it is possible to consider the airframe noise generated, which is especially important when attempting to accurately model noise levels from low-thrust CDAs. Other evaluations of CDAs have also been performed recently at the Nottingham East Midlands airport in the UK, Schiphol Airport in the Netherlands and Sacramento's Mather airport in the U.S. Like the Louisville effort, these evaluations focused on CDA design and implementation.

Unlike other efforts that have involved modeling a very limited number of CDAs under tightly controlled conditions, this paper applies enhancements to current methods for modeling aircraft flight paths for environmental analysis to determine the potential airport-wide benefits of CDAs at a major U.S. airport. The demonstration and assessment of this capability was performed using portions of the FAA's Aviation Environmental Design Tool (AEDT), which will eventually fully incorporate the INM and EDMS, as well as FAA's System for assessing Aviation's Global Emissions (SAGE) and the Model for Assessing Global Exposure to the Noise of Transport Aircraft (MAGENTA)[6,7]. The study is considered one of several capability demonstrator sample problems that have been undertaken in support of continued AEDT development.

Flight Operation Definitions

The capability demonstration undertaken under this effort models average daily arrival operations for a single operating configuration at Los Angeles International Airport (KLAX). This airport was chosen for the demonstration because it exhibits variation in vertical approach profiles and therefore provides a good example of the potential for noise, emissions and fuel burn benefits due to the implementation of CDA procedures. Many airport-specific factors determine the amount of fleet mix and flight trajectory variation that will exist at a given airport. Four days of the FAA/NASA Performance Data Analysis and Reporting

System (PDARS)[8] based radar data were used to define the average daily flight operations and the baseline flight profiles for this demonstration. Modeled flights were limited to flights from aircraft with FAA weight classifications of F (757), H (Heavy), and L (Large). Operations associated with aircraft in these categories are expected to contribute significantly to the noise and emissions produced around the modeled airport. These categories also include most aircraft types for which the detailed flight performance data necessary to model noise and emissions from radar data exists within the ANP database.

Aircraft types are identified within the radar data using the International Civil Aviation Organization (ICAO) four-letter aircraft codes (e.g. B737), which do not have the fidelity to identify the specific aircraft model versions and engine configurations needed for accurately modeling noise and emissions. AEDT contains the aircraft performance data necessary to derive thrust, and therefore noise and emission levels, from radar data for a limited set of aircraft. The aircraft noise and performance data within AEDT are directly analogous to the data available within the ANP database. AEDT also contains data on the emissions produced by a limited set of aircraft engines. Consequently, not all of the flights observed in the radar data could be included in this capability demonstration. Mappings were developed between FAA Aircraft Identifiers and supported AEDT aircraft/engine identifiers with the goal of capturing as many of the aircraft types found in the radar data as possible.

Scaling factors were developed to adjust the total number of flight operations per aircraft weight classification to make up for flights that were observed in the radar data but not included in the demonstration because the flights involved aircraft types that could not be properly modelled. As flight performance data become available for more aircraft types, the need to rely on scaling factors for this type of analysis will decrease. Table 1 displays, by weight classifications, the total flight count found in the radar data, the flight count of successfully mapped aircraft, and the resulting operations scaling factor.

FAA Weight Class	Flight Count within Radar Data	Flight Count for Successfully Mapped AC	Operations Scaling Factor
F	253	252	1.0040
H	414	355	1.1662
L	1585	1045	1.5167

Table 1: Operations Scaling Factors

The arrival flight operations for this capability demonstration and assessment were separated into three approach types: Downwind, Straight-In, and Southern. Baseline ground tracks were defined directly from radar data, assigning a unique track to each flight operation. As detailed in the PARTNER CDA study at KSDF, aircraft flying CDA procedures typically fly consistent, pre-defined ground tracks to ensure that an optimal CDA flight path is achieved. Unfortunately, no such ground tracks have been defined for the modelled airport to date. Therefore, for this demonstration a single nominal CDA track was derived from the appropriate baseline radar tracks for each approach type and runway end combination. A graphical depiction of the baseline and CDA ground tracks for each approach type is shown in Figure 1.

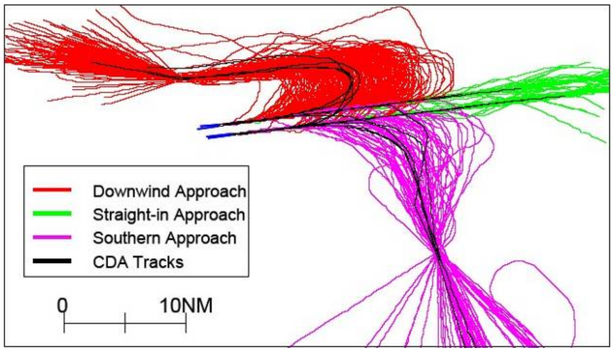

Figure 1: Radar and CDA Ground Tracks per Approach Type

The extent to which CDAs can be realistically implemented at the modelled airport is not known at this time. The level of CDA implementation will be dictated by numerous ATM considerations that are beyond the scope of this demonstration. Given this context, the demonstration attempts to determine the noise, emissions and fuel burn impacts from a range of possible CDA implementation levels, spanning the current baseline (with no CDAs) to a scenario where every arrival is a CDA, with four graduated steps in between.

CDAs require carefully determined minimum separation distances at high altitudes to ensure that aircraft do not violate the minimum in-trail separation distances prior to landing[9]. Therefore, the most significant factor determining whether or not a CDA can be flown is likely to be the level of traffic congestion for a given stream of traffic or approach route. With this in mind, the four graduated steps between the baseline and the full CDA implementation scenarios are defined using traffic flow thresholds independently applied to flights on each of the three modelled approach routes. These traffic flow thresholds specify the number of flights within a given 15-minute time period that can be accommodated while flying CDAs. The four traffic thresholds are equal to 1, 2, 3, and 4 flights per 15-minute time period per approach route, respectively. These threshold values were chosen because they represent somewhat even steps between the all-baseline and all-CDA scenarios. For each scenario using traffic thresholds, if the number of flights within a given 15-minute time period is below the given traffic flow threshold, all flights during that period are modelled using CDA profiles along CDA ground tracks, rather than following the radar-defined trajectories. Figure 2 displays the number of arrivals per 15-minute interval for the Straight-In approach route. Table 2 contains the total percentage of CDA operations per scenario, with each scenario including flight operations on all three approach routes.

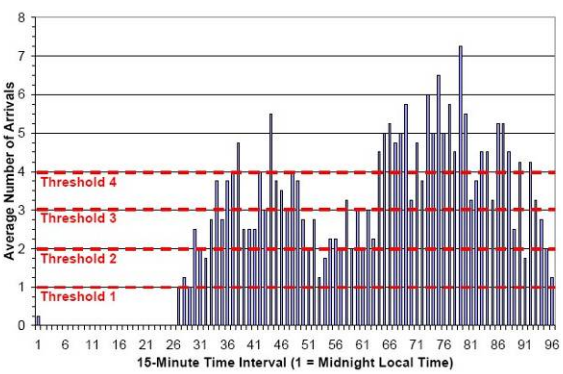

Figure 2: Average Daily Straight-In Arrivals

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

Table 2: CDA Operation Percentages

Baseline Flight Profile Definitions

The baseline aircraft flight profiles used were derived directly from radar data. Every modeled baseline flight operation follows the flight profile and ground track observed in the radar data for that operation. Altitude vs. track distance values for the baseline flight profiles from each of the three modeled approach routes are displayed in Figures 3-5.

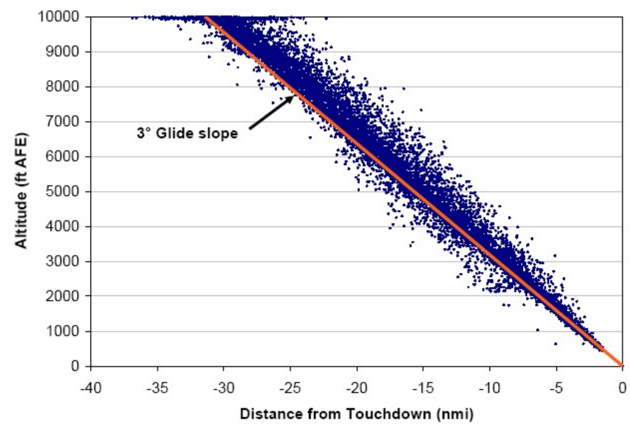

Figure 3: Baseline Straight-In Approaches

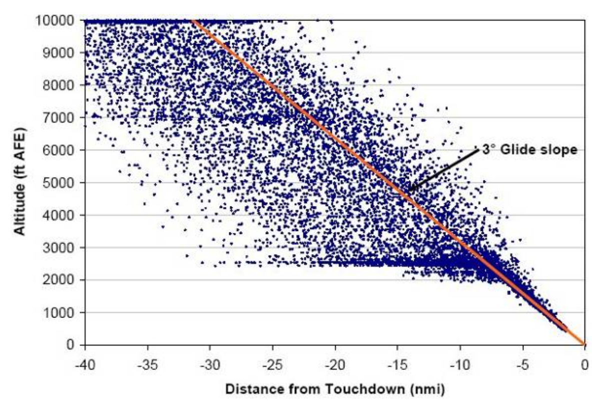

Figure 4: Baseline Downwind Approaches

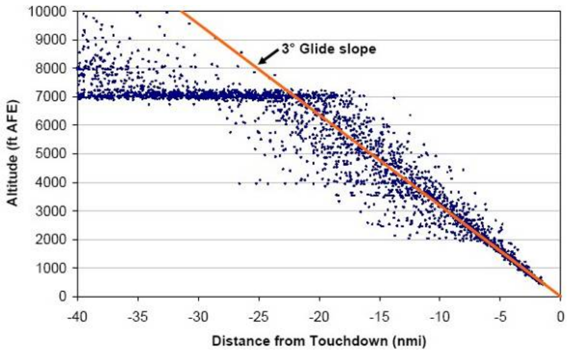

Figure 5: Baseline Southern Approaches

CDA Flight Profile Definitions

Detailed CDA procedures have not yet been defined for arrivals at the modeled airport. This is a complex process which involves coordination across various organizations within the FAA, as well as the airport authority. In the absence of real procedure definitions, hypothetical profiles have been developed to represent CDAs for this capability demonstration. As noted above, the Straight-In approach trajectories observed in the radar data are similar to those that would be expected from CDA operations. The hypothetical CDA profiles are therefore based on these Straight-In approach trajectories.

The hypothetical CDA profiles used in this capability demonstration follow a constant 3-degree glideslope from an altitude of 10,000 ft above field elevation (AFE) to touchdown. This represents the optimum trajectory typically targeted when designing CDAs. Since the Straight-In operations generally follow this trajectory, the speed schedule followed during the CDA profiles is obtained from the radar data for those flights. The speed schedule for each modeled aircraft's CDA profile is set equal to the average speed schedule observed in the Straight-In arrival radar data for that aircraft type.

Calculating Noise and Emissions from Radar and Hypothetical CDA Trajectories

Radar data can provide more realistic approach trajectories than the single manufacturer-supplied trajectory for each aircraft available in the ANP database. Radar data, however, is missing some of the information needed for environmental modeling, most importantly aircraft power or thrust values along the flight path. Several groups currently have processes for determining aircraft thrust levels from radar data using the aircraft performance data and flight path calculation equations contained in SAE-AIR-1845 and ECAC Doc 29. The latest revision of ECAC Doc 29 also includes some guidance on how this can be done, however no detailed, standardized guidance exists for this kind of process. Therefore a new methodology for deriving aircraft thrust levels from aircraft position data such as radar has been developed the this capability demonstration..

DNL Contour Comparisons

Day Night Average Sound Level (DNL) contours were calculated for each of the six scenarios (Baseline or No-CDA, Threshold 1, Threshold 2, Threshold 3, Threshold 4 and All-CDA). Table 3 details the change in DNL contour areas relative to the Baseline scenario. For most contour levels, as the number of CDA operations increases the size of the contour decreases, as would be expected. The benefit due to CDAs generally increases as the contour level decreases, representing the affects of the greater differences between the baseline and CDA profiles at higher altitudes and greater distances from the airport.

DNL Level (dB)	% Change in Contour Area Relative to Baseline				
	Thr. 1	Thr. 2	Thr. 3	Thr. 4	All-CDA
45	-1.4%	-5.7%	-10.5%	-14.2%	-15.9%
50	0.0%	-2.8%	-4.7%	-6.4%	-8.1%
55	-0.5%	-2.0%	-3.7%	-5.2%	-7.9%
60	-0.2%	-1.9%	-4.1%	-6.1%	-9.0%
65	-0.1%	-0.7%	-1.8%	-2.7%	-4.4%
70	0.7%	3.7%	4.6%	6.1%	7.9%
75	-0.3%	4.4%	6.0%	8.4%	11.4%
80	-0.9%	3.7%	4.6%	5.5%	7.3%

Table 3: DNL Contour Area Differences

In the region very close to the airport (associated with higher level DNL contours), little difference would be expected between baseline and CDA profiles, as they both typically fly the 3-degree glideslope. For this demonstration, the area covered by the higher DNL level contours actually increased with increasing CDA operations (shaded cells in the table). These contours have very small areas to start with and relative area comparisons between them are therefore very sensitive to modeling inputs. It is suspected that the change in contour areas seen in this demonstration is due to speed differences between the baseline and CDA profiles. This issue will be investigated further.

Figure 6 presents overlays of the DNL contours from the baseline and all-CDA scenarios. Significant changes occur in the general shapes of the outer contours, in addition to a substantial decrease in overall area for the All-CDA scenario. These changes in shape can be attributed to the affects of the concentrated ground tracks being followed by the CDA operations relative to the dispersed ground tracks observed in the radar (baseline) data and shown in Figure 1. The CDA ground tracks do not have the horizontal dispersion typically associated with the baseline ground tracks. Relative to the baseline, the CDA ground tracks concentrate the sound exposure and thus increase the DNL contour lengths along their centerlines, but also tend to reduce the width of the contours for this same reason. The net change is an increase in the overall contour area.

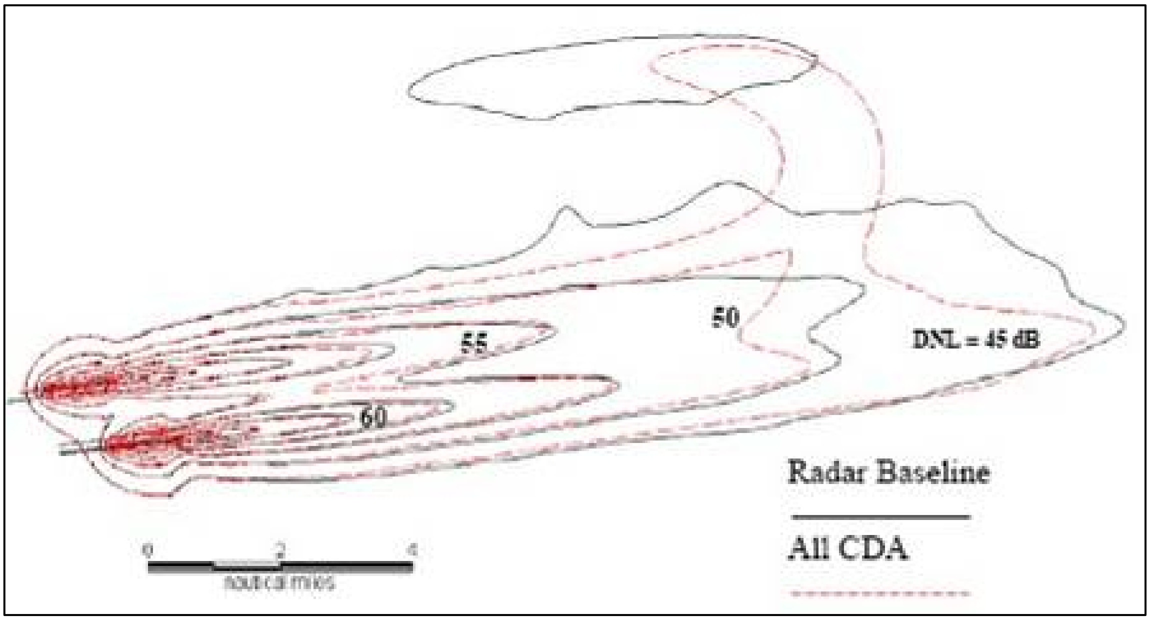

Figure 6: Baseline and All-CDA DNL Contour Overlays

SEL Grid Point Comparisons

As noted above, the trajectories flown on the three approach routes vary significantly from one another. To evaluate the noise benefits of CDAs relative to the trajectories observed for each individual approach type, A-Weighted Sound Exposure Levels (SEL) were calculated at a series of grid points. The locations of these grid points are specified in one nautical mile increments along each of the CDA ground tracks, which represent average or nominal tracks. The grid points are defined along the centerline of each CDA ground track as well as perpendicular to each ground track, with the perpendicular spacing between the points also equal to one nautical mile. Figure 7 displays the grid point locations defined along the CDA ground tracks for one of the airport runways.

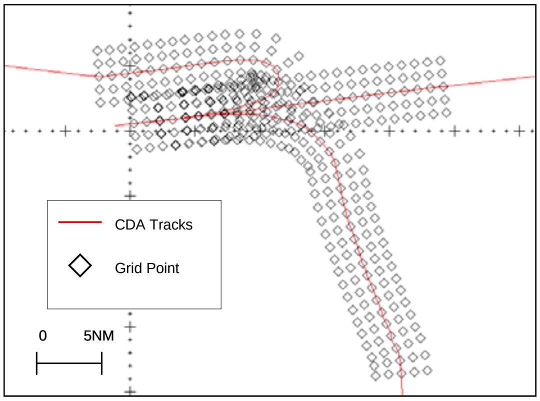

Figure 7: SEL Grid Point Locations

SEL values were calculated at grid points along the appropriate ground track for only Straight-In, only Downwind, and only Southern flight operations for all baseline profiles on baseline ground tracks. SEL values were also calculated in the same manner for flight operations for all CDA profiles on CDA ground tracks. These two sets of SEL values allow for the evaluation of the benefits of CDAs relative to each of the three types of baseline flight profiles observed from the radar data. Figure 8 contains the relative differences between these two sets of SEL values for each approach route, CDA minus baseline. Differences are given at grid points along the centreline of the appropriate CDA ground track as well as at grid points perpendicularly offset from the CDA ground track.

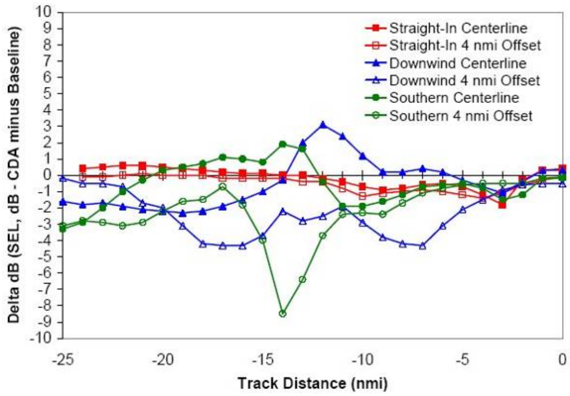

Figure 8: Runway 24R SEL Comparison

Figure 8 shows very small differences in noise levels from CDAs relative to the Straight-In approach trajectories. This is to be expected as the CDA profiles used in this demonstration are derived from the Straight-In approach trajectories. A greater benefit due to CDAs is shown relative to the Downwind and Southern approach trajectories. For both of these approach types, at certain track distances, CDAs cause an increase in SEL levels along the CDA ground track centerlines. The increasing noise at these track distances is due to differences in ground track dispersion between the baseline and CDA ground tracks noted above. At these same track distances, the grid points offset from the centerline show significant noise benefits due to CDAs.

Emissions and Fuel Burn Comparisons

Airport-wide fuel burn and emissions levels were calculated for each of the six scenarios (Baseline or No-CDA, Thresholds 1-4, and All-CDA). In all cases fuel burn and emissions levels decreased with increasing use of CDA profiles. Table 4 includes fuel burn and emissions level comparisons below 3,000 ft AFE, while Table 5 includes comparisons up to 10,000 ft AFE.

Emis.	**% Change Relative to Baseline**				
	Thr. 1	**Thr. 2**	**Thr. 3**	**Thr. 4**	**All-CDA**
CO	-0.2	-1.6	-3.7	-5.5	-6.8
THC	-0.1	-0.9	-2.2	-3.4	-4.5
NMHC	-0.1	-0.9	-2.2	-3.4	-4.5
VOC	-0.1	-0.9	-2.2	-3.4	-4.5
NOx	-1.7	-6.0	-13.1	-21.7	-28.4
SOx	-1.2	-4.5	-9.7	-15.6	-19.9
CO_2	-1.2	-4.5	-9.7	-15.6	-19.9
H_2O	-1.2	-4.5	-9.7	-15.6	-19.9
Fuel	-1.2	-4.5	-9.7	-15.6	-19.9

Table 4: Emissions and Fuel Burn Differences Below 3,000 FT AFE

Emis.	**% Change Relative to Baseline**				
	Thr. 1	**Thr. 2**	**Thr. 3**	**Thr. 4**	**All-CDA**
CO	-1.6	-4.7	-7.8	-10.8	-14.5
THC	-1.4	-4.0	-6.0	-8.7	-12.8
NMHC	-1.4	-4.0	-6.0	-8.7	-12.8
VOC	-1.4	-4.0	-6.0	-8.7	-12.8
NOx	-4.4	-12.0	-20.8	-31.2	-40.7
SOx	-3.8	-10.0	-16.8	-24.3	-31.5
CO_2	-3.8	-10.0	-16.8	-24.3	-31.5
H_2O	-3.8	-10.0	-16.8	-24.3	-31.5
Fuel	-3.8	-10.0	-16.8	-24.3	-31.5

Table 5: Emissions and Fuel Burn Differences Below 10,000 FT AFE

The results in Tables 4 and 5 indicate that with the reduced thrust levels used during CDA profiles, fuel burn, NOx, SOx, CO_2, and H_2O decrease accordingly. Fuel burn and these emissions are also decreased due to the reduction in total flight time for the CDA profiles. For CO, THC, NMHC, and VOC, a reduction in thrust and therefore fuel flow generally results in increases in the emissions indices (EIs). Since the overall effect is that all of these emissions were decreased, the reduction in flight time and fuel burn appears to have overridden any effects of an increase in EIs.

Fuel burn and emissions levels were also evaluated on a per approach route basis, similar to the per approach route SEL evaluation discussed above. The per approach route fuel burn and emissions results are analogous to the noise results in that they show the smallest differences between the fuel burn and emissions from the CDA and Straight-In approach profiles, and greater differences for the Downwind and Southern approach profiles relative to CDAs. Below 3,000 ft AFE the Downwind approach route shows the greatest benefits from CDAs due to the high percentage of Downwind approach profiles with level segments at 2,500 ft AFE. Below 10,000 ft AFE the Southern approach route shows the greatest benefit because almost all of the Southern approach profiles level off at 7,000 ft AFE. The per-approach route results are included in Tables 6 and 7.

Emission	% Change Relative to Baseline		
	Straight-In	Downwind	Southern
CO	-3.1	-11.0	-3.2
THC	-2.4	-7.8	-2.2
NMHC	-2.4	-7.8	-2.2
VOC	-2.4	-7.8	-2.2
NOx	-14.0	-30.3	-20.8
SOx	-9.8	-24.6	-14.4
CO_2	-9.8	-24.6	-14.4
H_2O	-9.8	-24.6	-14.4
Fuel	-9.8	-24.6	-14.4

Table 6: Emissions and Fuel Burn Differences per Approach Type Below 3,000 ft AFE

Emission	% 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

Table 7: Emissions and Fuel Burn Differences per Approach Type Below 10,000 ft AFE

Trajectory Dispersion

Modeling every single trajectory for an airport wide study could be computationally prohibitive for large airports, and only being able to model realistic baseline operations based on historical radar data does not allow for projecting baseline operations into the future. Furthermore, it is desirable to have a method that could be used to accurately model baseline operations at airports for which large amounts of radar data are not available or are difficult to obtain due to restrictions on data access or limitations on modeling resources.

One potential solution to these problems is to use radar data to create a small number of representative or nominal ground tracks and flight profiles for a given airport using the concept of dispersion. The process for creating dispersed horizontal ground tracks is discussed in the latest version of ECAC Doc 29, and the same concept can also be applied to vertical flight profiles. These dispersed nominal ground tracks and flight profiles would represent trends in the actual aircraft trajectories, and flight operations would be distributed across the nominal tracks and profiles based on the actual distribution observed in the radar data. Multiple sets of nominal profiles would be required to catch differences between flight profiles from different approach routes (i.e., straight-in approaches, long downwind approaches, short downwind approaches, etc.) and airport operating configurations. An example of a simple set of nominal vertical profiles for a given approach route type generated using simple averaging is presented in Figure 9.

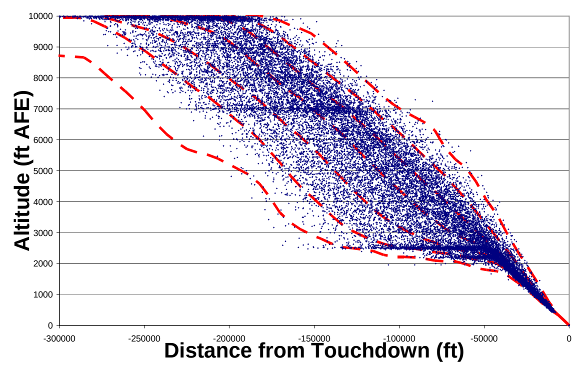

Figure 9: Simplified Nominal Profiles for Downwind Approaches

The challenge in developing nominal vertical profiles is balancing the complexity of the nominal profiles versus the level of detail required to obtain accurate noise and emissions predictions from the nominal profiles. The simple trajectories in Figure 9 average out many level flight segments and therefore would not account for the additional thrust, noise, and fuel burn that would be generated by those level flight path segments. Further effort is needed to determine the simplest dispersion method that will yield acceptable accuracy in terms of predicted noise, fuel burn, and emissions.

Discussion

This AEDT demonstration represents an initial effort to model the airport-wide noise, emissions and fuel burn benefits of CDAs using AEDT. As such, it has several limitations that are likely to affect the results. These limitations will be addressed, to the extent possible, in future CDA modeling analyses. These limitations include:

a) Lack of CDA Profile Definitions

The use of hypothetical CDA profiles is required in the absence of actual CDA profile definitions for the modeled airport. Differences between the hypothetical profiles and actually implemented CDAs could significantly affect the capability demonstration results.

b) Unknown CDA Implementation Issues

Details on the extent to which CDAs can realistically be implemented at the modeled airport are not available at this time. Details on any airspace design changes necessary to accommodate CDAs at the modeled airport are also not known at this time. An attempt to get around the first issue was made by modeling a range of CDA implementation levels for this demonstration, but it is difficult to quantify the exact benefits due to CDAs without knowing the actual level of CDA implementation. The second issue could significantly affect the actual benefits to be derived from CDA implementation, but all of the potential affects on the airspace are too complex to cover with a simple range of inputs.

c) Limited Operations Data Set

This initial demonstration only made use of four days worth of radar data, and only looked at arrival operations from one operating configuration over those four days. When determining the affects of CDAs for average annual noise metrics such as DNL it is important to include any seasonal affects on the airport's operations. It is also important to analyze both departure and arrival operations for all airport operating configurations to quantify any "drowning out" of the sound exposure benefits from CDAs due to departure traffic and changing operating configurations.

d) Limited Aircraft Performance Data

The AEDT database relied upon for this demonstration does not include flight performance coefficients for approach operations for most Airbus aircraft and a number of newer Boeing aircraft. This precludes flights from these important aircraft types being included in the demonstration. In addition, the ANP database within AEDT does not include coefficients for the calculation of idle thrust levels, which results in potential under-prediction of thrust levels when aircraft are at idle for both baseline and CDA profiles. If this type of analysis is to be done in support of significant ATM design decisions, data for additional aircraft types will likely need to be added to the AEDT/ANP databases.

e) Limited Use of Wind Data

The atmospheric data used for this demonstration were simply averaged temperature, pressure, and wind speed values at ground level obtained from Aviation Routine Weather Report (METAR) data for the four days for which radar data were obtained. A lack of actual wind speed and direction values for various altitudes matching the conditions that each radar trajectory actually encountered reduces the ability to accurately determine aircraft thrust values from radar data.

Despite these limitations, the AEDT CDA modeling capability demonstration is an important first step towards the goal of a robust capability to model the environmental benefits of CDAs, which is supports the goal of more wide-spread CDA implementation. This type of effort serves to identify gaps in current environmental modeling methods and data, and also serves as a platform for new development to fill those gaps.

Conclusion

CDA operations can have significant noise, fuel burn, and emissions benefits. The extent of these benefits can vary between areas around the airport depending on the differences between existing flight profiles and ground tracks and CDA profiles and ground tracks. The FAA is developing the capability of modeling the overall benefits, as well as the extent to which they may differ around an airport in its AEDT. This capability is of the utmost importance to the ATM community when evaluating CDA implementation efforts, and also when doing trade-off comparisons between different operational mitigation options.

There are several gaps in both available data required for environmental modeling and methods normally used for defining aircraft flight profiles that may reduce the ability to accurately quantify benefits due to CDAs. More robust CDA analyses in support of ATM decisions will require these gaps to be filled, including the inclusion of performance data for more aircraft types within the AEDT/ANP databases and standardized methods for defining realistic distributions of current non-CDA approach profiles using aircraft position data from sources such as radar.

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Key Words

Continuous descent approach, noise, emissions, fuel burn, environmental benefits.

Biography

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