

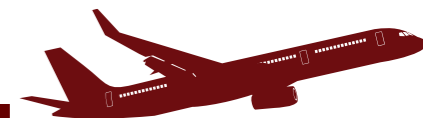


# CEE 4674 / CEE 5614

## Aviation Databases and Web Information

Dr. Antonio A. Trani

Fall 2023





# Aviation Databases

- Numerous resources available on the Internet
- Data is a key component in aviation studies and analysis
- The databases described here is just a sample of that available
- It is important to be familiar with aviation datasets to help you plan and design airports and create aviation models
- Links to important databases:
- [http://128.173.204.63/cee5614/sites\\_ce\\_5614.html](http://128.173.204.63/cee5614/sites_ce_5614.html)

**CEE 4674 and CEE 5614**

***World Wide Web Links***



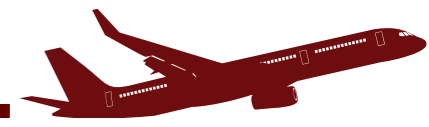


- [Airport Databases, Flight Planning and Aviation Statistics](#)
- [FAA and NASA Links](#)
- [Aircraft Manufacturer Data for Airport Design](#)
- [Computer Software](#)
- [Aviation Magazines](#)
- [FAA NextGen and NPIAS Plans](#)
- [Airport Contractors and Hardware](#)
- [Aviation Weather Information](#)
- [Airlines and aircraft production lists](#)

Boeing MD-90-30 Climbs at Atlanta Airport (A. Trani).

Airport and Aircraft Databases, Flight Tracking, Great Circle Calculator.

Site	Purpose
<b>Airport Data</b>	
<a href="#">AirNav Airport Information</a>	Airport information, fuel prices, navigation aids information.
<a href="#">FAA US Airport Diagrams</a>	Contains latest versions of airport diagrams used by pilots. Only US airports. Good to visualize airport layouts and to know details on runways and taxiways at airports.
<b>Aircraft Performance</b>	
<a href="#">Eurocontrol Aircraft Performance Database</a>	Contains a simplified version of the aircraft performance of the Eurocontrol BADA database.
<a href="#">Great Circle Flight Path Mapper</a>	Computes great circle (shortest path) distance between airports worldwide.
<b>Aircraft Pictures and Identification</b>	
<a href="#">Airliners.net</a>	Good site to see aircraft and airport photographs. See my link to airports that we will discuss in class.
<a href="#">A. A. Trani pictures and aircraft identification</a>	My site of pictures and quick descriptions to identify aircraft.
<b>Flight Tracking</b>	
<a href="#">Flightradar24.com</a>	Flight tracking site.
<a href="#">Flightaware.com</a>	Flight tracking site. Also contains airport information such as a approach and departure procedure charts to all US airports.
<a href="#">Planefinder.net</a>	Flight tracking site.
<b>Airport Delays and Airline Statistics</b>	
<a href="#">Intermodal and Aviation Transportation Database (BTS)</a>	Multi-modal transportation database with excellent query capabilities.
<b>Aviation Incidents and Accidents</b>	
<a href="#">Aviation Herald</a>	Contains aircraft incident and accident reports useful in airport design and aviation safety analysis
<a href="#">NTSB Database</a>	Database of accidents maintained by the National Transportation Safety Board



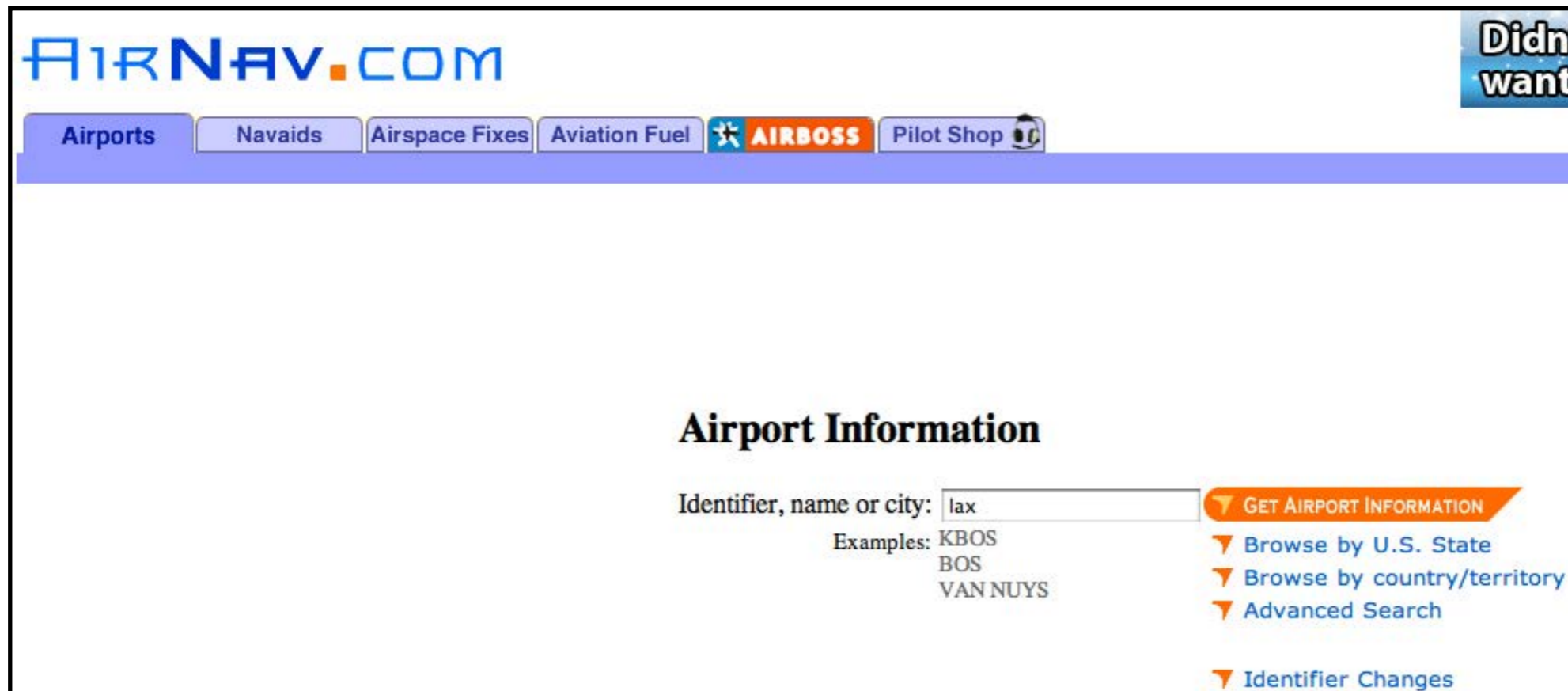
# Relevant Databases

- Airport and navigation systems information
- Aviation demand (passengers) and flight operations (departures and arrivals)
- Flight tracking
- Airline statistics (schedules, passengers, etc.)
- Aircraft performance and general aircraft information
- Aviation calculators
- Aeronautical charts and maps



# Airport and Navigation Systems Information

- Airnav.com (<http://www.airnav.com>)
  - Contains airport, navigation fix and fuel facilities data
  - Generally good for U.S. airports
  - Detailed information on runways, obstacles, etc.



The screenshot shows the AirNav.com website interface. At the top left is the logo "AIRNAV.COM". To the right is a "Didn't want" button. Below the logo is a navigation bar with tabs for "Airports", "Nav aids", "Airspace Fixes", "Aviation Fuel", "AIRBOSS", and "Pilot Shop". The main content area is titled "Airport Information". It features a search input field with the text "lax" and a "GET AIRPORT INFORMATION" button. Below the input field are examples: "KBOS", "BOS", and "VAN NUYS". To the right of the search field are several dropdown menus: "Browse by U.S. State", "Browse by country/territory", "Advanced Search", and "Identifier Changes".



# Los Angeles International Airport (LAX) Runway 7L/25R Information

## Runway 7L/25R

Runway dimension and pavement surface condition including weight bearing capacity

Dimensions: 12923 x 150 ft. / 3939 x 46 m  
 Surface: concrete/grooved, in good condition  
 Weight bearing capacity: PCN 70 /R/A/W/T  
 Single wheel: 175.0  
 Double wheel: 225.0  
 Double tandem: 400.0  
 Dual double tandem: 900.0

Runway edge lights: high intensity

### RUNWAY 7L

Latitude: 33-56.133107N

Longitude: 118-25.323892W

Elevation: 114.8 ft.

Traffic pattern: right

Runway heading: 071 magnetic, 083 true

Displaced threshold: 832 ft.

Declared distances: TORA:12091 TODA:12091 ASDA:12091  
 LDA:11259

Markings: precision, in good condition

Visual slope indicator: 4-light PAPI on left (3.00 degrees glide path)

RVR equipment: touchdown, midfield, rollout

Approach lights: MALSR: 1,400 foot medium intensity approach lighting system with runway alignment indicator lights

Runway end identifier lights: no

Centerline lights: yes

Touchdown point: yes, lighted

Instrument approach: ILS/DME

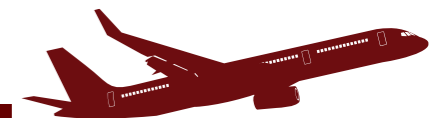
Obstructions: none

Runway threshold elevation

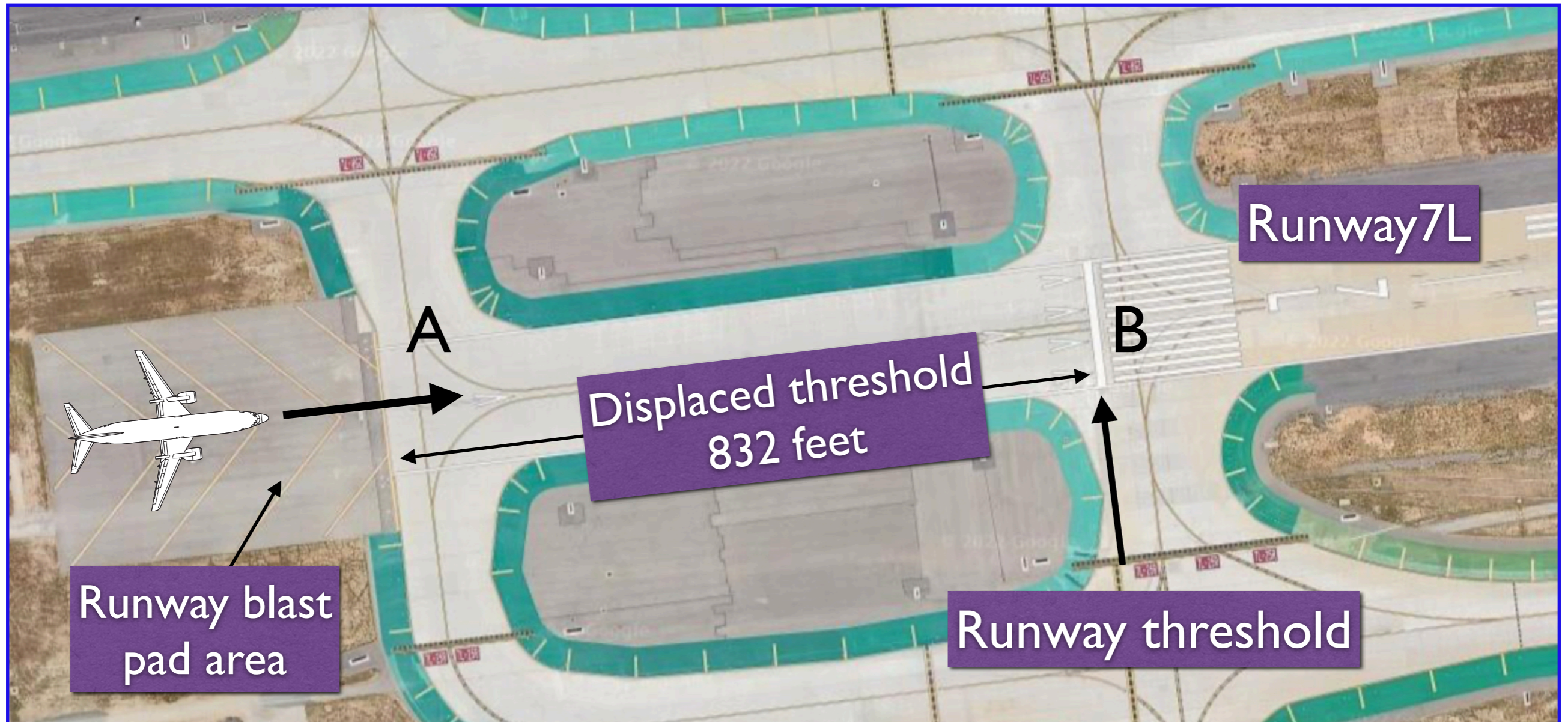
Displaced threshold  
832 feet

Runway heading, displaced threshold and declared distances

Runway visual slope indicator and runway approach lights



# Los Angeles International Airport Runway 7L/25R information



Source: Google Maps

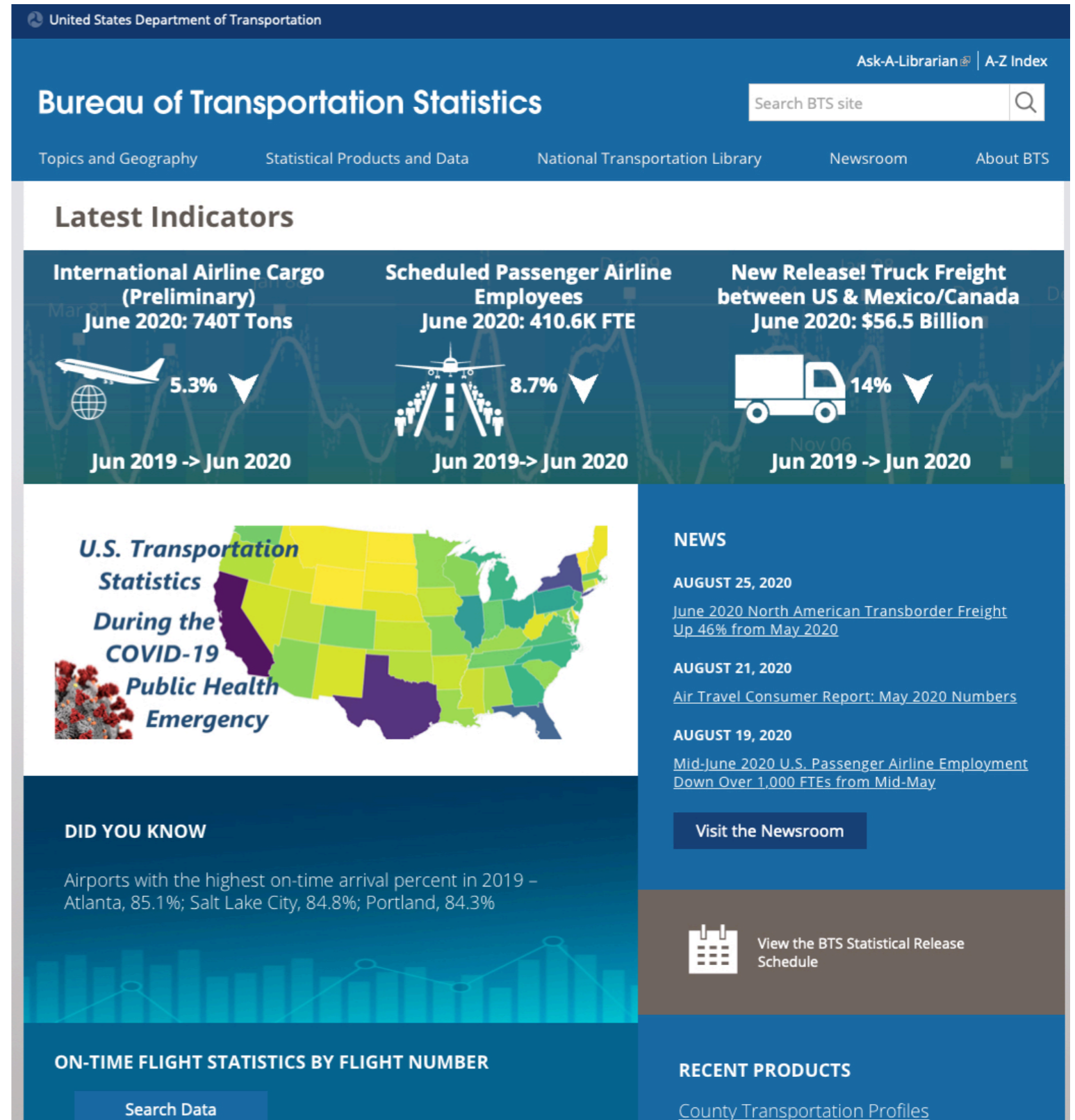
Aircraft can start the takeoff roll at **point A**

Aircraft must land after **point B**



# Bureau of Transportation Statistics

- <https://www.bts.gov>
- Good source of aviation statistical information
- Large public databases
- Airport, airline ticket prices, and passenger information



United States Department of Transportation

Ask-A-Librarian | A-Z Index

**Bureau of Transportation Statistics**

[Topics and Geography](#) | 
 [Statistical Products and Data](#) | 
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**Latest Indicators**


International Airline Cargo (Preliminary)	Scheduled Passenger Airline Employees	New Release! Truck Freight between US & Mexico/Canada
June 2020: 740T Tons	June 2020: 410.6K FTE	June 2020: \$56.5 Billion
5.3% ▼	8.7% ▼	14% ▼
Jun 2019 -> Jun 2020	Jun 2019-> Jun 2020	Jun 2019 -> Jun 2020

**U.S. Transportation Statistics During the COVID-19 Public Health Emergency**

**NEWS**

- AUGUST 25, 2020**  
[June 2020 North American Transborder Freight Up 46% from May 2020](#)
- AUGUST 21, 2020**  
[Air Travel Consumer Report: May 2020 Numbers](#)
- AUGUST 19, 2020**  
[Mid-June 2020 U.S. Passenger Airline Employment Down Over 1,000 FTEs from Mid-May](#)

[Visit the Newsroom](#)

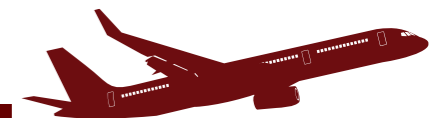
 [View the BTS Statistical Release Schedule](#)

**ON-TIME FLIGHT STATISTICS BY FLIGHT NUMBER**

[Search Data](#)

**RECENT PRODUCTS**

[County Transportation Profiles](#)



# Airline and Airport Statistics

(<https://www.bts.gov/topics/airlines-and-airports-0>)

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Home » Airlines and Airports

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- Statistical Releases
- On-Time
- Performance
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- Traffic
- Databases
- Products
- Related Resources
- Forms and Regulations

ports databases

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  - Airline On-Time
  - Airline Traffic
  - Air Fares
  - Passenger Airline Employment
- On-Time
- Performance
  - Fares
  - Mishandled Baggage Reports
  - Passengers Denied Confirmed Space Report
  - Airline Origin and Destination Survey (DB1B)
  - Overbookings
  - Airport Snapshots
  - Carrier Snapshots





# Bureau of Transportation Statistics

## (<http://www.transtats.bts.gov/>)

- Contains aviation (passenger, airline, and airport) information



**RITA** Research and Innovative Technology Administration  
Bureau of Transportation Statistics

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RITA > BTS

**TranStats**

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- Data Release History

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**By Mode**

- Aviation
- Maritime
- Highway

**Quick Answers**

- [Carrier Snapshots](#)
- [Airline Fuel Cost and Consumption](#)
- [Air Freight Summary](#)
- [Employment](#)
- [Airport Snapshots](#)
- [Holiday Flight Delays](#)
- [Inter-Airport Distances](#)
- [Tarmac Times](#)

**Airline Activity : National Summary (U.S. Flights)**

	2013 *	2014 *	Change
<b>Enplaned Passengers (million)</b>	643	649	0.9%
<b>Departures (000)</b>	8,784	8,592	-2.2%
<b>Freight/Mail (million lbs)</b>	19,673	20,128	2.3%
<b>Load Factor (%)</b>	83.6	84.1	0.5 points
<b>Airlines with scheduled service</b>	99	95	-4.0%

\* 12 months ending May of each year

**Airline Domestic Market Share June 2013 - May 2014**

**At a Glance**

**Flight Delays** [more...](#)

Percent of U.S. Flights On Time (2013-2014)



Click a bar for details. Mouseover it for percentage.

**Average Air Fares** [more...](#)

Average Domestic Airline Fares



# BTS Airport Snapshot

(<https://www.transtats.bts.gov/airports.asp?pn=1>)

Bureau of Transportation Statistics

Topics and Geography
Statistical Products and Data
National Transportation Library

Atlanta Airport

Atlanta served 45.94 million arrival passengers in 2019

**Select a month:**  
January 2019

The month selection does not apply to on-time data.)

**Select an airport:**  
Atlanta, GA: Hartsfield-Jackson Atlanta Internat

[Show all airports \(by state\)](#)

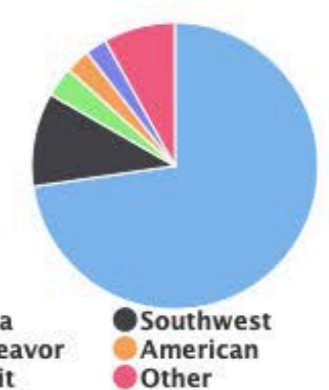
Submit

**Atlanta, GA: Hartsfield Jackson Atlanta International (ATL)**
Scheduled Services except Freight/Mail
BTS Data as of 8/27/2023

Summary Data (U.S. Flights Only)
Carrier Shares for February 2018 - January 2019

Passengers*	2018**	2019**	%Chg	Rank***
Arrival	44,346k	45,941k	3.60%	1
Departure	44,304k	45,865k	3.52%	1
<b>Scheduled Flights</b>				
Departures	387,193	394,569	1.90%	1
<b>Freight/Mail (lb.) Scheduled and Non-Scheduled</b>				
Total	655m	664m	1.28%	16
<b>Carriers</b>				
Scheduled	22	23	4.55%	

Carrier	Passengers	Share
<b>Delta</b>	66,749	72.71%
<b>Southwest</b>	9,743	10.61%
<b>Endeavor</b>	3,105	3.38%
<b>American</b>	2,554	2.78%
<b>Spirit</b>	2,245	2.45%
<b>Other</b>	7,410	8.07%



\* Scheduled enplaned revenue passengers.

\*\* 12 months ending January of each year.

\*\*\* Among 795 U.S. airports, 12 months ending January 2019



# Smaller commercial airports are also included in the airport snapshot (select **Show all airports**)

**Bureau of Transportation Statistics** Search BTS site

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 [Statistical Products and Data](#)   
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BTS > [TranStats](#)

Select a month:    
(The month selection does not apply to on-time data.)

Select an airport:

[Show all airports \(by state\)](#)

---

**Atlanta, GA: Hartsfield-Jackson Atlanta International (ATL)**   
 Scheduled Services except Freight/Mail   
 BTS Data as of 8/29/2022

transtats.bts.gov/NewAirportList.asp?Acntr=nv421465.n52&synt=SNPgf

<a href="#">Vero Beach, FL: Vero Beach Regional (VRB)</a> <a href="#">West Palm Beach/Palm Beach, FL: Palm Beach International (PBI)</a>	<a href="#">Virginia Beach, VA: Norfolk International (PHF)</a> <a href="#">Lynchburg, VA: Lynchburg Regional (LYH)</a> <a href="#">Newport News/Williamsburg International (PHF)</a> <a href="#">Norfolk, VA: Norfolk International (ORF)</a> <a href="#">Norfolk, VA: Norfolk NS (NGU)</a> <a href="#">Richmond, VA: Richmond International (RIC)</a> <a href="#">Roanoke, VA: Roanoke Blacksburg Regional Woodrum Field (ROA)</a> <a href="#">Staunton, VA: Shenandoah Valley Regional (SHD)</a> <a href="#">Washington, DC: Ronald Reagan Washington National (DCA)</a> <a href="#">Washington, DC: Washington Dulles International (IAD)</a>
<b>Georgia</b> <a href="#">Albany, GA: Southwest Georgia Regional (ABY)</a> <a href="#">Athens, GA: Athens/Ben Epps (AHN)</a> <a href="#">Atlanta, GA: Hartsfield-Jackson Atlanta International (ATL)</a> <a href="#">Augusta, GA: Augusta Regional at Bush Field (AGS)</a> <a href="#">Brunswick, GA: Brunswick Golden Isles (BQK)</a> <a href="#">Columbus, GA: Columbus Airport (CSG)</a> <a href="#">Macon, GA: Middle Georgia Regional (MCN)</a> <a href="#">Savannah, GA: Savannah/Hilton Head International (SAV)</a> <a href="#">Valdosta, GA: Valdosta Regional (VLD)</a>	<div style="background-color: #800000; color: white; padding: 10px; text-align: center;"> <h2>Roanoke/Blacksburg Regional Airport</h2> </div>



# BTS Site Airline Snapshot

(<https://www.transtats.bts.gov/carriers.asp?pn=1>)

Delta Airlines
Bureau of Transportation Statistics

Topics and Geography
Statistical Products and Data
National Transportation Library
Newsroom

Select a month:  Select a carrier:

(The month selection does not apply to Revenue and Costs and On-Time Summary)

Carriers with annual operating revenue over \$20M

[Passenger](#) [Cargo](#)

**Delta Air Lines (DL)** Scheduled Services Only BTS Data as of 8/31/2020

Summary Data (U.S. Airports, 12 Months Ending August)					Top Domestic Markets* (September 2018 - August 2019)		
	2018	2019	%Chg	Rank <sup>1</sup>	Market	Passengers	Share**
Passengers	124,117k	132,945k	7.11%	2	<b>Atlanta, GA</b>	34.14m	72.89%
Departures	936k	975k	4.23%	2	<b>Minneapolis, MN</b>	9.17m	53.22%
RPM 2	119,266m	128,323m	7.59%	2	<b>New York, NY</b>	7.89m	27.87%
ASM 3	137,615m	146,549m	6.49%	3	<b>Detroit, MI</b>	7.77m	48.71%
Loadfactor	86.7%	87.6%	0.90 pts	1	<b>Salt Lake City, UT</b>	6.31m	52.08%
Air Cargo 4	463m	425m	-8.14%	2	<b>Other</b>	67.66m	9.97%
Markets Served	163	161	-1.23%				
Share 5	16.82%	17.31%	0.49 pts	2			

<sup>1</sup> Among 0 passenger carriers for 2019

<sup>2</sup> Revenue Passenger Miles

<sup>3</sup> Available Seat Miles

<sup>4</sup> Air Cargo is the sum of Freight and Mail in pounds.

\* Based on total enplaned passengers at all airports in a city.

\*\* The table shows the carrier's share in each of the markets. The pie chart shows each market's share in the carrier's total air passengers.



# Bureau of Transportation Statistics (BTS)

United States Department of Transportation

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**Bureau of Transportation Statistics**

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Topics and Geography | Statistical Products and Data | National Transportation Library

**Databases**

- **Aviation Databases (Transtats)**
- Aviation data in the National Transportation Atlas Database
- Information about Restricted Release Aviation Data

- Dedicated section of the database to aviation
- Air carrier statistics (form 41) (T100)
- Airline on-time performance
- Airline origin-destination survey (10% sample of tickets sold) called DB1B database

**TranStats**

Data Library: Aviation

Search this site:

Advanced Search

**Resources**

- Database Directory
- Glossary
- Upcoming Releases
- Data Release History

**Data Finder**

**By Mode**

- Aviation
- Maritime
- Highway
- Transit
- Rail
- Pipeline
- Bike/Pedestrian
- Other

**By Subject**

- Safety
- Freight Transport
- Passenger Travel
- Infrastructure
- Economic/Financial
- Social/Demographic

Database Name	Description	Profile
<a href="#">Air Carrier Financial Reports (Form 41 Financial Data)</a>	Form 41 Financial Schedule consists of financial information on large U.S. certified air carriers--includes balance sheet, income statement, cash flow, aircraft inventory, aircraft operating expenses and operating expenses. <b>Note:</b> Numbers presented on B1, B11 Balance Sheet and P11, P12 Statement of Operations now follow the format of common public financial documents. This format reverses signs from the accounting format in which numbers appeared prior to 10/18/2006 ( <a href="#">Examples</a> ).	<a href="#">Profile</a>
<a href="#">Air Carrier Statistics (Form 41 Traffic)- U.S. Carriers</a>	Monthly data reported by certificated U.S. air carriers on passengers, freight and mail transported. Also includes aircraft type, service class, available capacity and seats, and aircraft hours ramp-to-ramp and airborne.	<a href="#">Profile</a>
<a href="#">Air Carrier Statistics (Form 41 Traffic)- All Carriers</a>	Monthly data reported by certificated U.S. and foreign air carriers on passengers, freight and mail transported. Also includes aircraft type, service class, available capacity and seats, and aircraft hours ramp-to-ramp and airborne.	<a href="#">Profile</a>
<a href="#">Air Carrier Summary Data (Form 41 and 298C Summary Data)</a>	Summary data of the non-stop segment and on-flight market data reported by air carriers on Form 41 and Form 298C	<a href="#">Profile</a>
<a href="#">Airline On-Time Performance Data</a>	Monthly data reported by US certified air carriers that account for at least one percent of domestic scheduled passenger revenues--includes scheduled and actual arrival and departure times for flights.	<a href="#">Profile</a>
<a href="#">Airline Origin and Destination Survey (DB1B)</a>	Origin and Destination Survey (DB1B) is a 10% sample of airline tickets from reporting carriers. Data includes origin, destination and other itinerary details of passengers transported.	<a href="#">Profile</a>
<a href="#">American Travel Survey (ATS) 1995</a>	National data on the nature and characteristics of long-distance personal travel, from a household survey conducted by BTS about every five years.	<a href="#">Profile</a>



# Bureau of Transportation Statistics (BTS)

- T100 air carrier data (form 41 in BTS web site)
- Contains **passenger enplanement** data at the airport and route levels
- Three key tables: a) market, b) coupon, and c) segment (international passengers only available for U.S. passengers only)

Search this site:

[Advanced Search](#)

**Resources**

- [Database Directory](#)
- [Glossary](#)
- [Upcoming Releases](#)
- [Data Release History](#)

**Data Finder**

**By Mode**

- [Aviation](#)
- [Maritime](#)
- [Highway](#)
- [Transit](#)
- [Rail](#)
- [Pipeline](#)
- [Bike/Pedestrian](#)
- [Other](#)

**By Subject**

- [Safety](#)
- [Freight Transport](#)
- [Passenger Travel](#)
- [Infrastructure](#)

**Database Name: Air Carrier Statistics (Form 41 Traffic)- U.S. Carriers**

[Databases](#) [Database Profile](#)

All Rows Shown

Table Name	Description
<p><b>Note:</b> Over time both the code and the name of a carrier may change and the same code or name may be assumed by a different airline. To ensure that you are analyzing data from the same airline, TranStats provides four airline-specific variables that identify one and only one carrier or its entity: Airline ID (AirlineID), Unique Carrier Code (UniqueCarrier), Unique Carrier Name (UniqueCarrierName), and Unique Entity (UniqCarrierEntity). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.</p>	
<a href="#">T-100 Domestic Market (U.S. Carriers)</a>	<p>This table contains domestic market data reported by U.S. air carriers, including carrier, origin, destination, and service class for enplaned passengers, freight and mail when both origin and destination airports are located within the boundaries of the United States and its territories.</p> <p style="text-align: right;"><a href="#">Table Profile</a> <a href="#">Carrier Release Status</a> <a href="#">Download</a></p>
<a href="#">T-100 Domestic Segment (U.S. Carriers)</a>	<p>This table contains domestic non-stop segment data reported by U.S. air carriers, including carrier, origin, destination, aircraft type and service class for transported passengers, freight and mail, available capacity, scheduled departures, departures performed, aircraft hours, and load factor when both origin and destination airports are located within the boundaries of the United States and its territories.</p> <p style="text-align: right;"><a href="#">Table Profile</a> <a href="#">Carrier Release Status</a> <a href="#">Download</a></p>
<a href="#">T-100 International Market (US Carriers Only)</a>	<p>This table contains international market data by U.S. air carriers, including carrier, origin and destination for enplaned passengers, freight and mail when at least one point of service is in the United States or one of its territories. International flight data is released 3 months after domestic data. Flights with both origin and destination in a foreign country are not included.</p> <p style="text-align: right;"><a href="#">Table Profile</a> <a href="#">Carrier Release Status</a> <a href="#">Download</a></p>
<a href="#">T-100 International Segment (US Carriers Only)</a>	<p>This table contains international non-stop segment data reported by U.S. carriers, including carrier, origin, destination, aircraft type and service class for transported passengers, freight and mail, available capacity, scheduled departures, departures performed, aircraft hours, and load factor when at least one point of service is in the United States or one of its territories. International flight data is released 3 months after domestic data. Flights with both origin and destination in a foreign country are not included.</p>




# Bureau of Transportation Statistics (Schedule B-43 US Aircraft Inventory)

Schedule B-43 Aircraft Inventory (2009) | Bureau of Transportation Statistics

www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/subject\_areas/airline\_information/schedule\_b43/2009/html/summary.html

ps Apple Wikipedia skyvector.com


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## Schedule B-43 Aircraft Inventory (2009)

By Aircraft Manufacturer and Aircraft Type

[Excel](#) | [CSV](#)

Carriers	Total Aircraft	Average Aircraft Age (2009)
<b>Cargo</b>		
ABX Air, Inc. (ABX)	60	32.5
Air Transport International (8C)	18	39.9
Aloha Air Cargo (AQ)	1	36.0
Amerijet International (M6)	8	33.0
Ameristar Air Cargo (AMQ)	4	39.3
Arrow Air Inc. (JW)	7	27.7
Asia Pacific (PFQ)	3	31.3
Astar USA, LLC (ER)	40	32.1



# Bureau of Transportation Statistics

## (Available Seat-Miles by Airport)

**TranStats**

Search this site:

[Advanced Search](#)

**Resources**

- Database Directory
- Glossary
- Upcoming Releases
- Data Release History

**Data Finder**

**By Mode**

- Aviation
- Maritime
- Highway
- Transit
- Rail
- Pipeline
- Bike/Pedestrian
- Other

**By Subject**

- Safety
- Freight Transport
- Passenger Travel
- Infrastructure
- Economic/Financial
- Social/Demographic
- Energy
- Environment
- National Security

### Available Seat-miles (the number of seats and the distance flown in thousands (000))

#### Delta Air Lines - All Airports

Select a carrier from the dropdown (major carriers) or from a link below: Select an airport:

Delta Air Lines

[U.S. Carriers \(\\$20M revenue/yr\)](#)   [Foreign Carriers, 10,000 pax/mo to and from U.S.](#)

\* All numbers are for scheduled services.

\* Most recent three months of international data by airport and by carrier withheld because of confidentiality agreements for individual routes. Summary totals are shown for all airports and all carriers. Foreign point-to-point totals not included. For U.S. carrier summary system and international numbers including foreign point-to-point and the foreign point-to-point totals, see [BTS monthly air traffic press releases](#)

\* Domestic and international data based on World Area Codes, a numerical code for each country and each U.S. state (T-100 database), rather than Domestic, Atlantic, Latin and Pacific regional geographic entities (T-1 database).

\* Jan. 2012: Atlantic Southeast (EV) and ExpressJet (XE) started to report jointly as ExpressJet (EV). Data for the airlines may be found by clicking on U.S. Carriers (\$20M revenue/yr). Clicking on ExpressJet Airlines Inc. (EV) will retrieve Atlantic Southeast (EV) data through December 2011 and the combined ExpressJet (EV) data beginning January 2012. Selecting ExpressJet Airlines Inc. (1) (XE) will retrieve ExpressJet (XE) data through December 2011.

\* Beginning in October 2002, monthly data reports were expanded to include data for carriers that fly aircraft with 60 seats or less or having a payload capacity of 18,000 lbs. or less, as well as domestic all-cargo carriers. For previous months, see T-100 for U.S. carrier, foreign carrier and individual airport passenger and flight data.

All

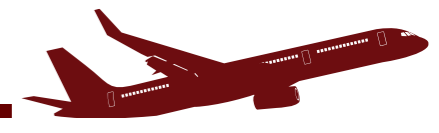
Origin

Destination

[Passengers](#)   [Flights](#)   [Revenue](#)   [Passenger-Miles](#)   [Available Seat-Miles](#)   [Load Factor](#)   [Net Income](#)   [Operating Revenue](#)

Year	Month	DOMESTIC	INTERNATIONAL	TOTAL
2002	10	8,332,093	2,766,881	11,098,974
2002	11	7,919,522	2,505,819	10,425,340
2002	12	8,127,073	2,405,204	10,532,277
<b>2002</b>	<b>TOTAL</b>	<b>99,461,315</b>	<b>31,221,978</b>	<b>130,683,293</b>
2003	1	8,152,502	2,363,170	10,515,672
2003	2	7,127,819	1,886,963	9,014,783
2003	3	8,052,021	2,202,747	10,254,768
2003	4	7,380,656	1,954,703	9,335,359
2003	5	7,302,481	2,022,747	9,325,228
2003	6	7,415,623	2,280,425	9,696,048





# BTS Geospatial Data Sets

United States Department of Transportation

**Bureau of Transportation Statistics**

Search BTS

Topics and Geography | Statistical Products and Data | National Transportation Library

**Databases**

- Aviation Databases (Transtats)
- Aviation data in the National Transportation Atlas Database**
- Information about Restricted Release Aviation Data

1-10 of 12 results Most Recent ▾

**Runway Ends** (from Open Data)  
USDOT\_BTS  
139 attributes | 14912 locations | ⬇️ ⭐

The Runway Ends is as of July 16, 2020, and is part of the U.S. Department of Transportation (USDOT)/Bureau of Transportation Statistics (BTS) National Transportation Atlas Database (NTAD). The geospatial Runway Ends dataset is associated with and contains runway ends from the runway database, where two geospatial elements were reported for a runway. The dataset contains runwa...

**Airports** (from Open Data)  
USDOT\_BTS  
107 attributes | 19850 locations | ⬇️ ⭐

The Airports dataset includes all official and operational aerodromes as of July 16, 2020 and is part of the U.S. Department of Transportation (USDOT)/Bureau of Transportation Statistics (BTS) National Transportation Atlas Database (NTAD). The Airports database is a geographic point database of official operational aerodromes in the United States and U.S. Territories. Attribute data is provided...

**Intermodal Freight Facilities – Air to Truck** (from Open Data)  
USDOT\_BTS  
6 attributes | 404 locations | ⬇️ ⭐

The Air-Truck Intermodal Freight Facilities dataset as of January 15, 2019 includes air to truck intermodal freight facilities for the top 60 airports by total freight moved in 2017. This dataset is one of several layers in the Bureau of Transportation Statistics (BTS) Intermodal Freight Facility Database.

**Runway Lines** (from Open Data – Transportation Infrastructure)  
USDOT\_BTS  
140 attributes | 7308 locations | ⬇️ ⭐

The Runway lines dataset is as of June 20, 2019 and is part of the U.S. Department of Transportation (USDOT)/Bureau of Transportation Statistics (BTS) National Transportation Atlas Database (NTAD). The geospatial Runways database contains runways in the United States and US territories containing information on the physical characteristics of the runways. This data layer c...

**Runway Nonspatial** (from Open Data – Transportation Infrastructure)  
USDOT\_BTS  
138 attributes | 11931 locations | ⬇️ ⭐

The Runways table is as of June 20, 2019 and is part of the U.S. Department of Transportation (USDOT)/Bureau of Transportation Statistics (BTS) National Transportation Atlas Database (NTAD). The geospatial Runways database contains runways in the United States and US territories and contain information on the physical characteristics of the runways. This data layer contains runwa...

**Runway Points** (from Open Data)  
139 attributes | 4398 locations | ⬇️ ⭐

**Airports** Open In ArcGIS Comments (0) Share Download Dataset ▾ APIs ▾

Details | Table | Charts

**Description** more ▾  
The Airports dataset includes all official and operational aerodromes as of July 16, 2020 and is part of the U.S. Department of Transportation (USDOT)/Bureau of Transportation Statistics (BTS) National Transportation Atlas Database (NTAD). The Airports database is a geographic point database of official operational aerodromes in the United States and U.S. Territories. Attribute data is provided on the physical and operational characteristics of the aerodrome, current usage

**About**  
Open Data  
By USDOT\_BTS  
Updated: 18 days ago  
Data available to the open data portal.  
Source <https://geo.dot.gov/server/rest/services/NTA/Metadata/Airports>  
License No license specified

**Dataset Attributes**

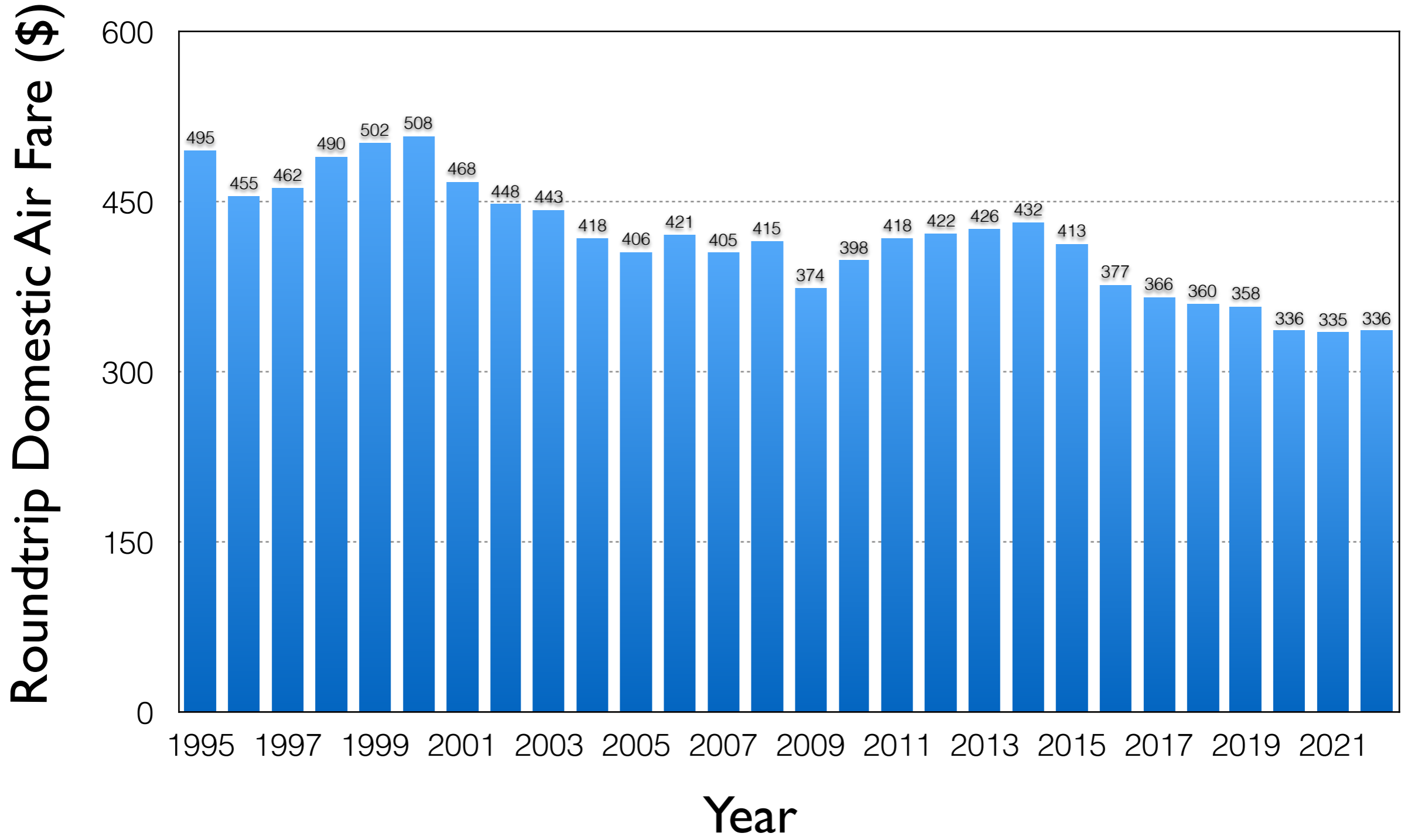
Rec_Type Text	APT (19850)
Site_Num Text	04104.*A (1), 03738.5*A (1), 03394.45*A (1), 11914.02*H (1), 04727.2*H (1), 00952.*A (1), 25725.2*H (1)... (993 more)
Fac_Type Text	AIRPORT (13235), HELIPORT (5935), SEAPLANE BASE (517), ULTRALIGHT (114), GLIDERPORT (36), BALLOONPORT (13)
Loc_Id	1QK (1), SN22 (1), 49MN (1), 48G (1), C43 (1), MI48 (1), ME27 (1), 08B

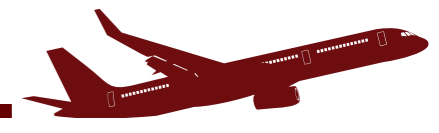
**Tags**  
Aviation | NTAD | National Transportation Atlas Database | National | Transportation | Atlas | Database | United States | United | States | National | Aviation | Airports | US | United | State | NTAD | National | Transportation | Atlas | Structures | Airport | Balloonport | Gliderport | Heliport | Seaplane Base | Ultralight



# Bureau of Transportation Statistics

## (Air Fares over Time - Inflation Adjusted \$2020)





# Flight Tracking flightaware.com

Note: Approximate Position of Aircraft in the Atlantic Ocean

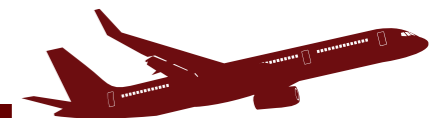
The screenshot displays the FlightAware interface for tracking American Airlines Flight 106. On the left, a navigation menu includes options like 'Live Flight Tracking', 'Pilot Resources', and 'Aviation Photos'. The main map shows the flight path from JFK to LHR. A green callout box points to the aircraft's position in the Atlantic Ocean. On the right, the flight details panel shows the following information:

<b>American Airlines 106</b> (Track inbound flight) AAL106 - "American" (all flights) aa.com	
John F Kennedy Intl (KJFK) Gate 8	London Heathrow (EGLL / LHR) Terminal 3
<b>08:13PM EDT</b> Scheduled: 07:40PM EDT 7-day average: 08:07PM EDT	<b>07:19AM BST (+1)</b> Scheduled: 07:13AM BST (+1) 7-day average: 07:27AM BST (+1)
Other flights between these airports	
2 hr 30 min   3 hr 35 min	
Duration: 6 hours 6 minutes Sunday, August 24, 2014	
<b>Status</b>	En Route / On Time (1,369 sm down; 2,176 sm to go)
<b>Aircraft</b>	Boeing 777-300ER (twin-jet) (H/B77W/L - photos)
<b>Speed</b>	538 kts (planned: 488 kts) (graph)
<b>Altitude</b>	33,000 feet (planned: 35,000 feet) (graph)
<b>Distance</b>	Direct: 3,446 sm Planned: 3,619 sm
<b>Route</b>	BETTE ACK DOVEY NATW BEDRA NATW NERTU GAPLI UL620 GIBSO UM17 BILNI

Below the flight details, there is a yellow alert box stating: "John F Kennedy Intl (KJFK) is currently experiencing departure delays an average of 35 minutes. How is anybody else affected? View the MiseryMap". At the bottom, there is a 'Share this alert with a friend' section with a text input field and a 'Submit' button.

Tracking American Airlines Flight 106  
JFK-LHR  
New York Kennedy to London Heatrow airports

Flight Plan Information



FlightAware LIVE FLIGHT TRACKING

Live Flight Tracker → American Airlines (AA) #106

**American Airlines 106**  
(Track inbound flight)  
AAL106 - "American" (all flights) aa.com

John F Kennedy Intl (KJFK) Gate 6  
London Heathrow (EGLL / LHR) Terminal 3

**08:13PM EDT** Scheduled: 07:40PM EDT  
7-day average: 08:07PM EDT

**07:19AM BST (+1)** Scheduled: 07:13AM BST (+1)  
7-day average: 07:27AM BST (+1)

Other flights between these airports

2 hr 30 min | 3 hr 35 min

Duration: 6 hours 6 minutes  
Sunday, August 24, 2014

Status: **En Route / On Time** (1,369 sm down; 2,176 sm to go)

Aircraft: Boeing 777-300ER (twin-jet) (H/B77WL - photos)

Speed: 538 kts (planned: 488 kts) (graph)

Altitude: 33,000 feet (planned: 35,000 feet) (graph)

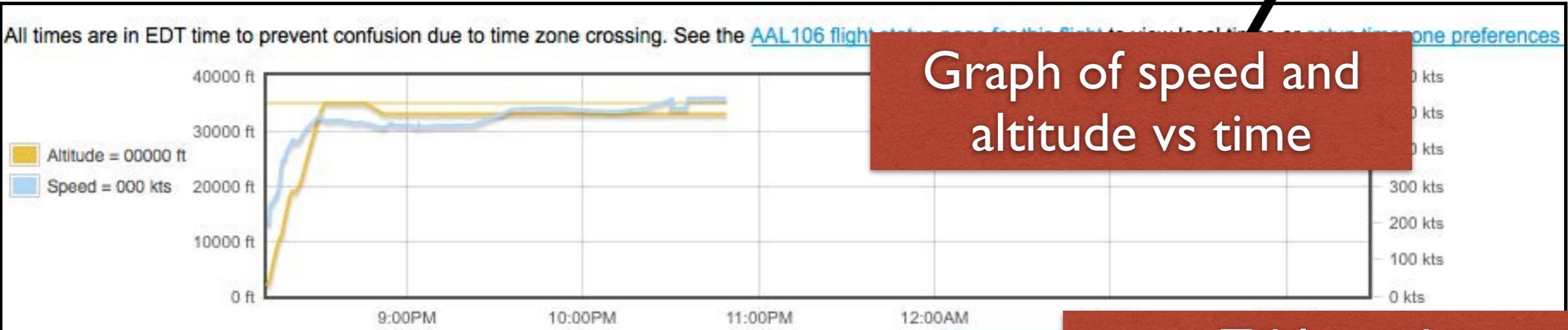
Distance: Direct: 3,446 sm Planned: 3,619 sm

Route: BETTE ACK DOVEY NATW BEDD... NERTU GAPLI UL620 GIBSO LM17 BILNI

John F Kennedy Intl (KJFK) is currently experiencing departure delays an average of 35 minutes.

How is everybody else affected? View the MissedMap

Share this alert with a friend  
friend@example.com Submit



Time EDT	Position		Orientation		Groundspeed		Altitude feet	Rate of Climb
	Latitude	Longitude	Course	Direction	KTS	MPH		
08:12PM	40.6039	-73.7472	145°	Southeast	197	227	1,800	
08:13PM	40.5796	-73.7148	145°	Southeast	197	227	2,500	
08:13PM	40.5749	-73.6917	100°	East	242	278	2,900	
08:13PM	40.5731	-73.6710	95°	East	249	287	3,500	2,400 ↑ FA FlightAware ADS-B
08:13PM	40.5718	-73.6498	93°	East	250	288	4,100	2,400 ↑ FA FlightAware ADS-B

Table with georeferenced speed and altitude vs time



# Flight Tracking Information (flightaware.com)

- Example of departure procedure at LAX
- Terminal area procedures are key to operate in and out of all airports

## LAX IFR Departure Procedure Imper One

**FlightAware**
toni trani (vuela123) | Registered Member Since 2007 | Wednesday 12:05PM EDT
English (USA)

Live Tracking

Flight Planning

Pilot Resources

Photos

Squawks & Headlines

Discussions

Commercial Services

About FlightAware

Contact

FlightAware > Pilot Resources > KLAX IMPER ONE (DP)

Overview
Flight Tracker
FBOs
Hotels
Weather
Map & Diagram
IFR Plates
VFR Sectional
Remarks

Browse By State or enter Airport Code:

Valid from 2010-Jul-29 02:01AM PDT to 2010-Aug-26 02:01AM PDT (times local to KLAX)

Always verify dates on each chart and consult appropriate NOTAMs. Ensure that all appropriate charts are included that are necessary for FAA/NACO and is not warranted by FlightAware.

Download PDF

**(IMPER1,IMPER) 09239**  
**IMPER ONE DEPARTURE**

NOTE: RADAR required.  
NOTE: Chart not to scale.

**DEPARTURE ROUTE DESCRIPTION**

**TAKE-OFF RUNWAYS 6L/R, 7L/R:** Climb via heading 070° for vector to SUJ VORTAC, then via SUJ R-120 and OCN R-301 to OCN VORTAC. Thence...

**TAKE-OFF RUNWAYS 24L/R, 25L/R:** Climb via heading 250° to cross SMO R-154 at or below 3000. Then via radar vectors to join LAX R-160 to GESME INT. Then via OCN R-270 to OCN VORTAC. Thence...

... via (assigned transition) or (assigned route). All aircraft expect further clearance to filed flight level three minutes after departure.

**LOST COMMUNICATIONS:** If not in contact with Departure Control within five minutes after departure, climb to FL230 or filed altitude whichever is lower. Aircraft filing FL240 or above climb to filed altitude ten minutes after departure.

**IMPERIAL TRANSITION (IMPER1, IPI):** From over OCN VORTAC via OCN R-083 and JU R-263 to JU VORTAC. Then via JU R-115 and IPI R-258 to IPI VORTAC.

**JULIAN TRANSITION (IMPER1, JU):** From over OCN VORTAC via OCN R-083 and JU R-263 to JU VORTAC.

**LOS ANGELES INTL (LAX)**  
LOS ANGELES, CALIFORNIA

**ATIS DEP 125.65**  
121.4 327.0  
CINC DEL  
GND CON  
N 121.65 327.0  
S 121.75 327.0  
LOS ANGELES TOWER  
N 133.9 239.3  
S 120.95 339.1  
SOCAL DEP CON  
124.3 363.2 (045°-234°)  
125.2 263.025 (225°-044°)

**TAKE-OFF MINIMUMS**  
Rwy 6L, 7L/R, 24L/R, 25L/R: Standard.  
Rwy 6R: 300-1¼ or standard with minimum climb of 231' per NM to 400'.

**SEAL BEACH**  
115.2 50  
Chen 104  
N03°47.00' W118°03.27'

**VISTA**  
N03°13.14' W117°14.07'  
5000  
(23)

**KJURBA**  
N03°45.77' W114°03.22'

**IMPERIAL**  
N33°08.47' W119°35.10'  
1-4, H-4

**IMPERIAL**  
115.9 PL  
(28)  
N03°44.50' W119°30.31'  
1-4, H-4

**IMPER ONE DEPARTURE**  
(IMPER1,IMPER) 09239

LOS ANGELES, CALIFORNIA  
LOS ANGELES INTL (LAX)

**Related Links**

- [KLAX Airport Flight Tracker](#)
- [KLAX Airport Information and Procedures](#)
- [KLAX Weather](#)
- [Buy KLAX Excel flight history](#)
- [Statistics and KLAX graphs](#)
- [Reserve a hotel room in Los Angeles, CA](#)
- [Book a KLAX rental car](#)
- [National and regional weather maps](#)

**Bundled Procedure ("Plates") Download**  
(right click to save)

- [All Departures \(DPs\)](#)
- [All Arrivals \(STARs\)](#)
- [All Approaches \(IAPs\)](#)
- [Special Minimums](#)
- [All KLAX Procedures \(with diagram\)](#)

**Other KLAX Procedures**

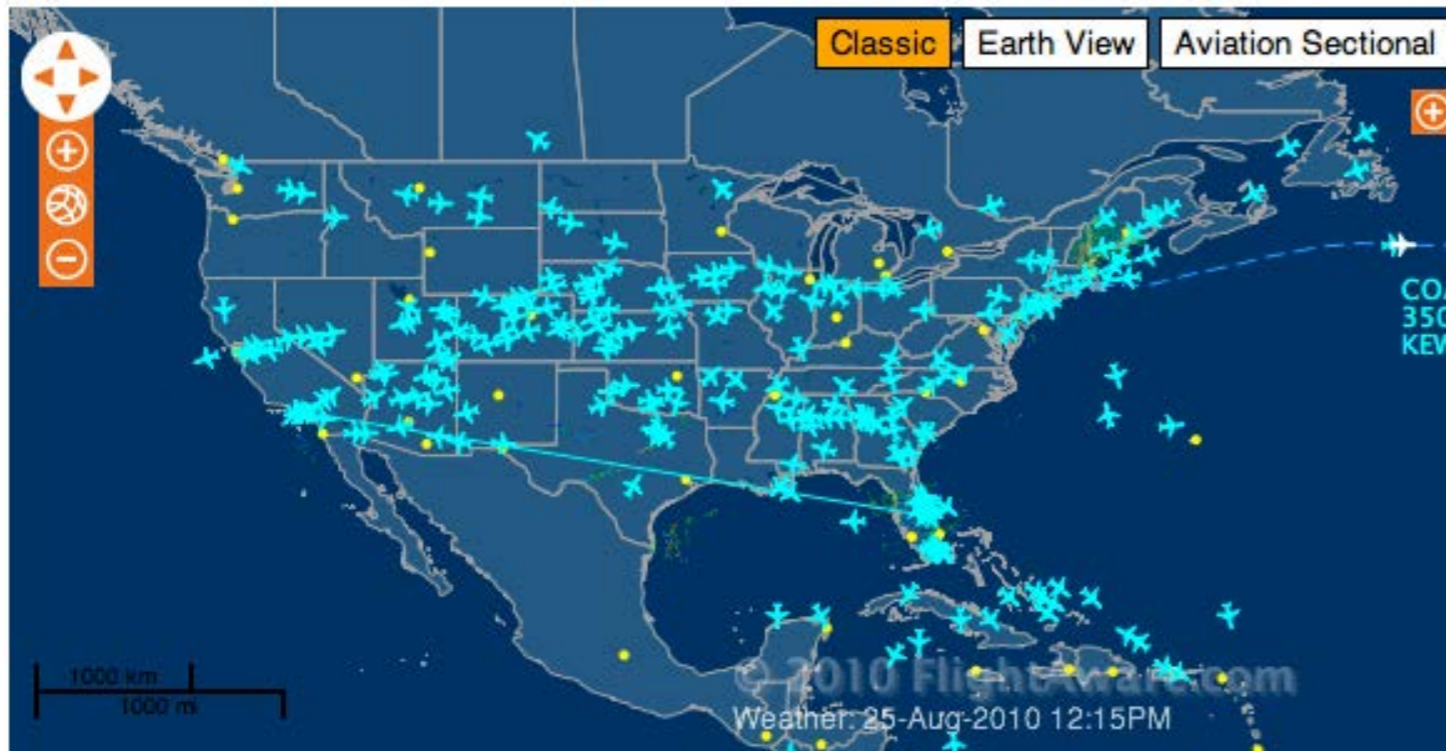
- APD : [AIRPORT DIAGRAM](#)
- DP : [CASTA TWO \(RNAV\)](#)
- DP : [CATALINA FIVE](#)
- DP : [CHATY TWO](#)
- DP : [GABRE SIX](#)
- DP : [GORMAN FOUR](#)
- DP : [HOLTZ NINE \(RNAV\)](#)
- DP : [IMPER ONE](#)
- DP : [JEDDD ONE \(RNAV\)](#)
- DP : [KARVR THREE \(RNAV\)](#)
- DP : [LAXX SIX](#)
- DP : [LOOP FIVE](#)
- DP : [OSHNN THREE \(RNAV\)](#)
- DP : [PERCH NINE](#)
- DP : [SAN DIEGO FIVE](#)
- DP : [SEAL BEACH FIVE](#)
- DP : [SEBRY FIVE](#)

Air Transportation Systems Laboratory

21



# Flightaware.com



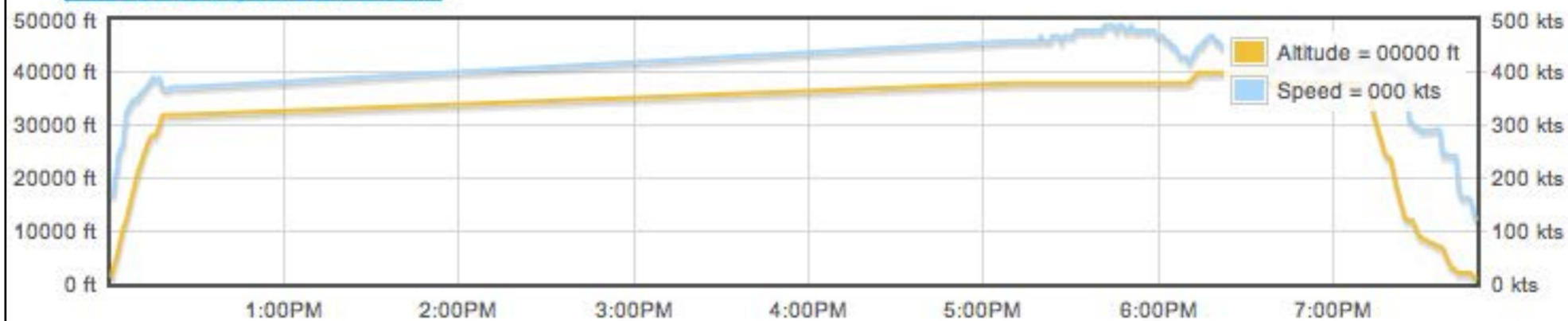
Tracking all Boeing 757 flights in the NAS

## Live Flight Track Log (AAL121) - Related Links

- [Live > AAL121 Flight Status](#)
- [Flight > AAL121 > 24-Aug-2010 > LFPG-KJFK](#)

## Times and Time Zones

All times are in USA: Eastern time to prevent confusion due to time zone crossing. See the [AAL121 flight status page for this flight](#) to view [preferences in your user account](#).



Flight track of American Airlines flight 121 (B757)



# Flight Tracking Information

( <http://www.radarbox24.com> )

**RadarBox24.com** AIRSPACE LIVE by AirNav Systems

Search flights, airports, places... [Search Icon]

About Apps Add Coverage Widget XML Flight Data Forum Login

096 squawked 7600 Lost Comm (12:30 UTC) Airport Events Favorites

**Flight** Grid Options

**KAI99** KAISERAIR  
Kaiser Air

From **KOA (PHKO)** To **OAK (KOAK)**  
Kailua/Kona Oakland

STD -- STA --  
ATD **12:30 PM GMT-10** ETA **8:05 PM GMT-7**

Image Not Available

Model <b>B737</b>	Registration <b>0</b>
Altitude <b>10000 ft</b> (3048 m)	Course <b>56 °</b>
Speed <b>294 kt</b> (544 km/h, 338 mph)	Squawk

Radar Station **KNCT**

Follow Route Cockpit

Show Details

The main map displays a satellite view of California and Nevada with numerous green aircraft icons. A specific flight path is highlighted in blue and green, starting from the Pacific Ocean and heading inland towards the San Francisco Bay Area.



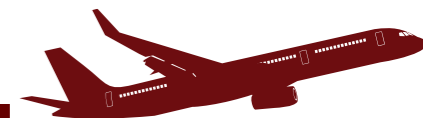
# Flight Tracking Information

( <http://www.radarbox24.com> )

Aircraft data tags include cruise altitude, speed, flight id and origin-destination airports





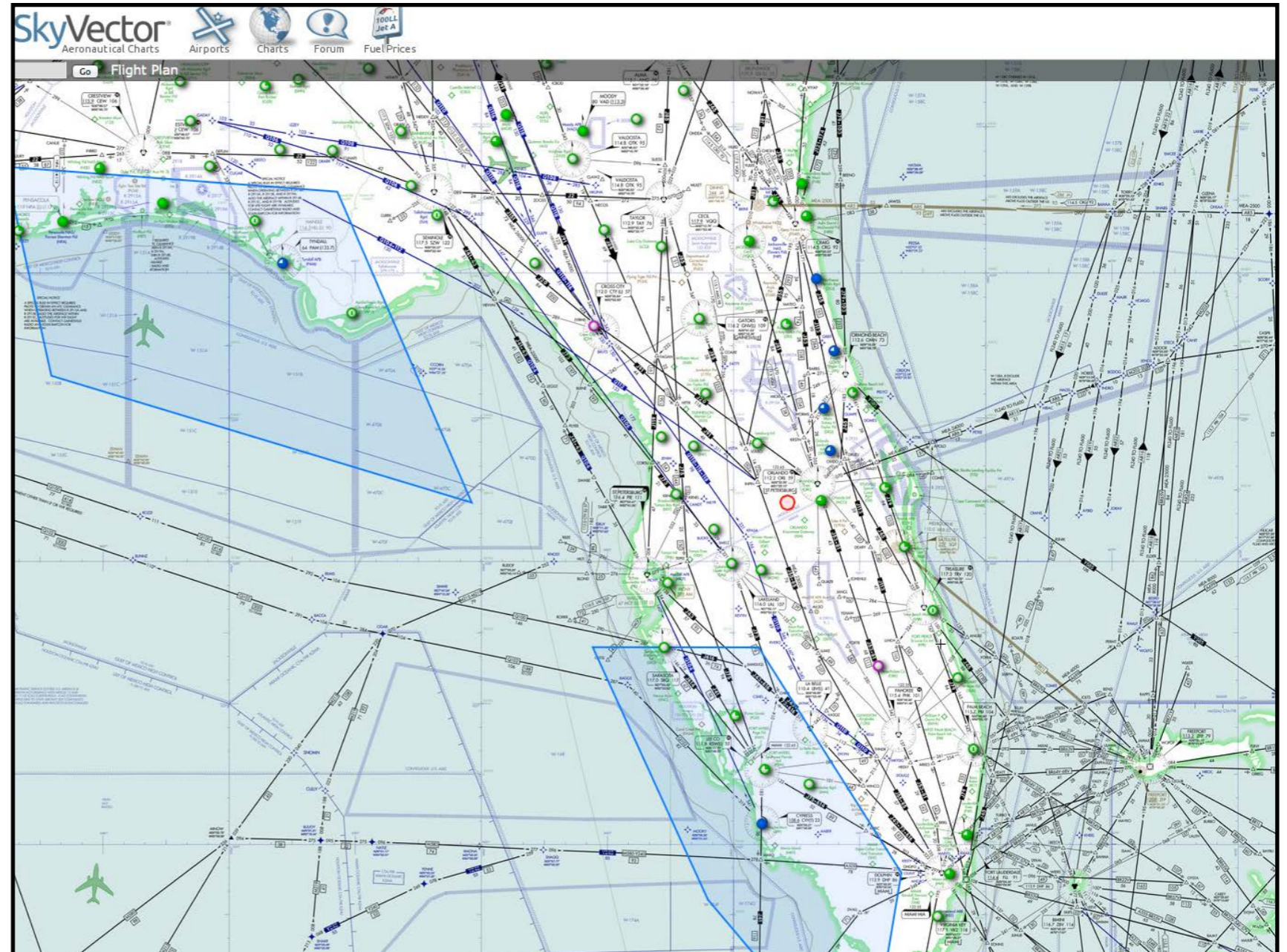


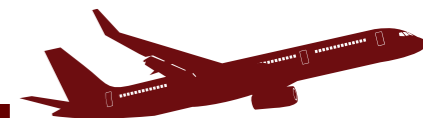
# Aeronautical Chart Information

## (<http://skyvector.com>)

- Skyvector.com
  - Contains aeronautical chart information
  - US and Worldwide

High Altitude  
(Jet) Airways in Florida





# Operations and Performance Database

- FAA Operations and Performance Data (<http://aspm.faa.gov/>)
- Contains airline and FAA traffic statistics
- Terminal Area Forecast contains past and future airport demand
- Some areas of ASPM are restricted to FAA employees



Federal Aviation  
Administration

## FAA Operations & Performance Data

FAA Operations and Performance Data provides access to historical traffic counts, forecasts of aviation activity, and delay statistics.

### Database Access Systems

- [Aviation System Performance Metrics \(ASPM\)](#)
- [Operational Network \(OPSNET\)](#)
- [Traffic Flow Management System Counts \(TFMSC\)](#)
- [Airline Service Quality Performance \(ASQP\)](#)
- [Terminal Area Forecast \(TAF\)](#)

- [System Descriptions](#)

### Reporting Systems

- [Business Jet Reports](#)



# FAA Operations and Performance Database

- Sample Java Applet to enter Terminal Area Forecast (TAF) queries
- 3368 airport facilities (all across the U.S.)



**Federal Aviation Administration** Back to FAA Opera

**Terminal Area Forecast (TAF)** Select a Different Operations

- Query Data
- Download Report
- Detailed 2009 Model
- Download 2009 Data
- 2008 TAF Changes
- Detailed 2008 Model
- Detailed 2007 Model
- Detailed 2006 Model
- Detailed Models prior to 2006
- What's New

Facility     Detail Report  
 State         Summary Report  
 Region  
 All

From: 1...  
 To: 2...

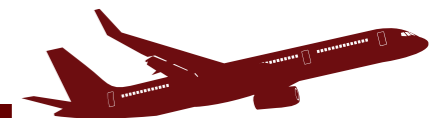
Find :

- MGM - MONTGOMERY RGNL
- MGN - HARBOR SPRINGS
- MGR - MOULTRIE MUNI
- MGW - MORGANTOWN MUNI-
- MGY - DAYTON-WRIGHT
- MHE - MITCHELL MUNI
- MHK - MANHATTAN RGNL
- MHL - MARSHALL MEMORIAL
- MUM - MINGUM MUNI

Create File

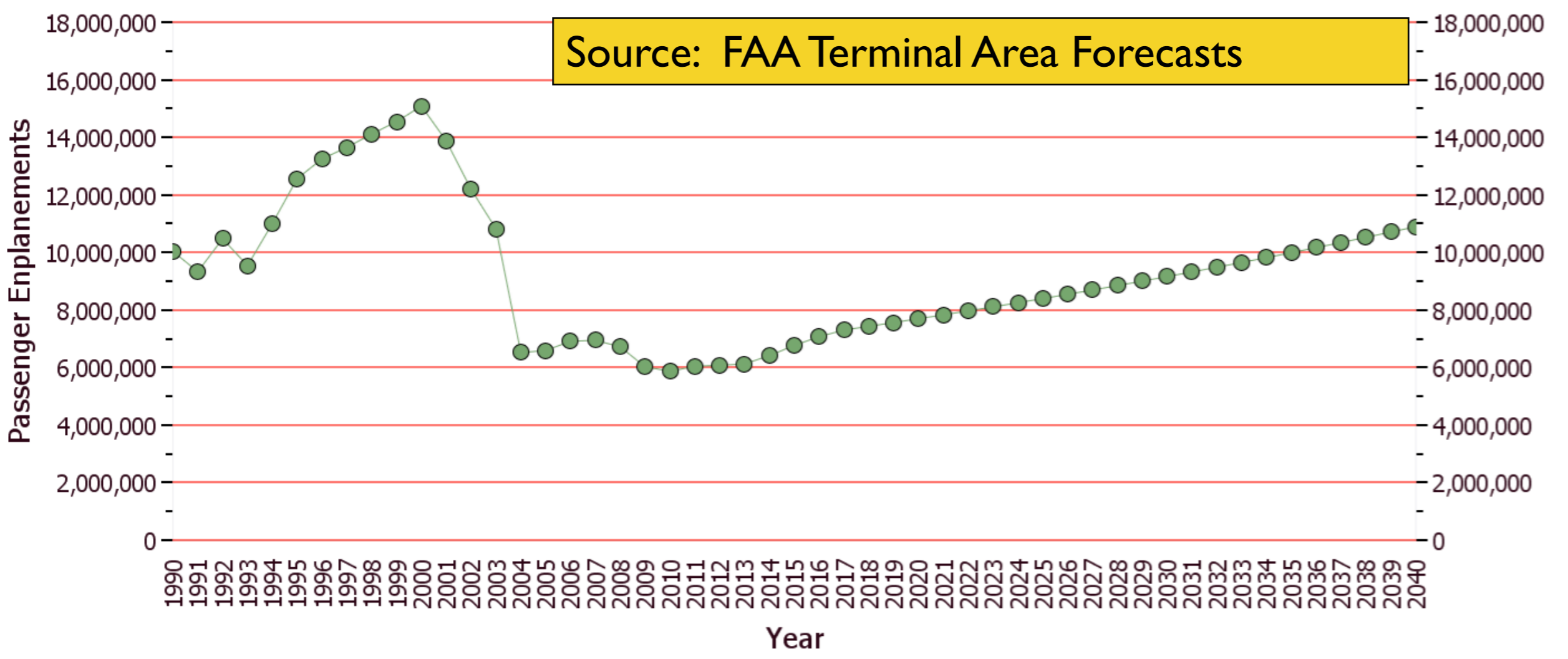
Ready.

If you do not see the query menu, then please go to [Java.com](http://Java.com) to download the free Java software.



# FAA Terminal Area Forecast Data

- I exported the data to plot the FAA forecast over time
- St. Louis International passenger demand forecasts over time
- One **passenger emplanement** means a passenger boarded a flight at St. Louis





# FAA Operations and Performance Database

- ASPM - Aviation System Performance Metric
- 77 airport facilities (large and medium hub airports)
- Provides information on actual flight operations, delays, airline performance, taxi times, etc.

## Aviation Performance Metrics : Airport Analysis : All Flights Report

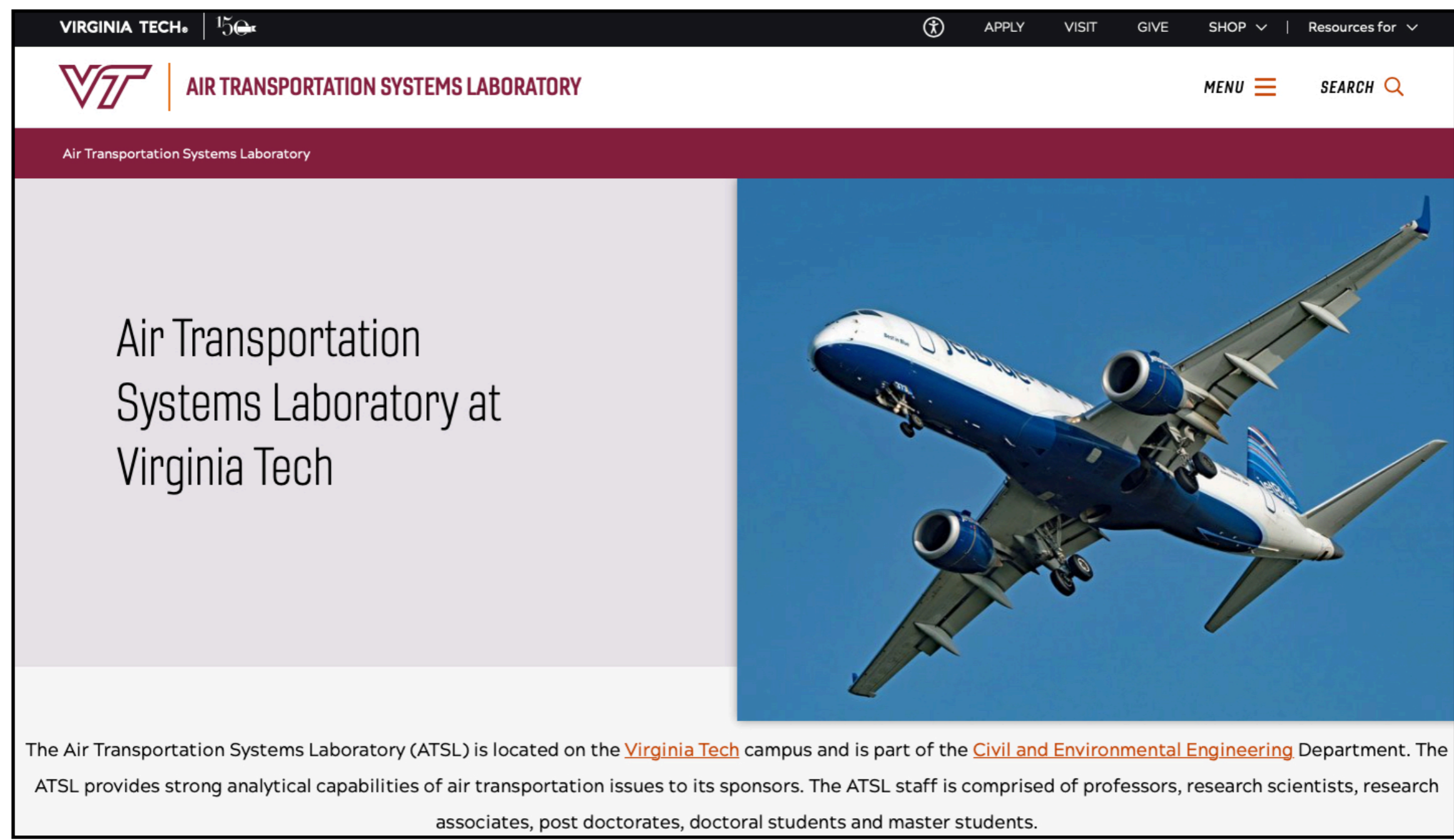
From 8/11/2010 To 8/11/2010 | Airport=LAX : Use Flight Plan

Facility	Hour	Scheduled Departures	Scheduled Arrivals	Departures For Metric Computation	Arrivals For Metric Computation	% On-Time Gate Departures	% On-Time Airport Departures	% On-Time Gate Arrivals	Average Gate Departure Delay	Average Taxi Out Time	Average Taxi Out Delay	Average Airport Departure Delay	Average Airborne Delay
LAX	0	12	10	7	9	100.00	100.00	88.89	1.86	15.71	2.60	3.57	0.44
LAX	1	14	0	7	0	71.43	57.14	0.00	10.71	13.29	1.89	12.57	0
LAX	2	4	1	4	2	75.00	75.00	100.00	10	11	0.80	10.75	8
LAX	3	4	1	3	3	100.00	100.00	100.00	2.67	12.67	2.13	4.67	0
LAX	4	2	5	4	10	100.00	100.00	100.00	1.50	10.25	0.38	1.75	0
LAX	5	1	12	5	15	80.00	80.00	86.67	5.40	13.20	3.06	8.20	0.67
LAX	6	41	16	45	14	91.11	91.11	78.57	4.96	13.67	2.92	7.22	2.79
LAX	7	53	33	54	27	92.59	85.19	100.00	5.93	15.56	4.36	9.57	3.37
LAX	8	62	33	59	31	89.83	86.44	93.55	5.56	13.19	2.07	7.25	1.97
LAX	9	36	54	33	51	78.79	66.67	92.16	13.18	15.64	4.76	17.64	1.80
LAX	10	52	43	50	40	92.00	70.00	92.50	8.54	16.96	5.39	13.42	2.53
LAX	11	50	50	49	49	83.67	81.63	71.43	12.39	14.20	3.44	15.55	2.61



# Aircraft Landing Events Database

## Database Created at the Virginia Tech Air Transportation Lab



The screenshot shows the website for the Air Transportation Systems Laboratory (ATSL) at Virginia Tech. The header includes the Virginia Tech logo and the text "AIR TRANSPORTATION SYSTEMS LABORATORY". Below the header, there is a navigation menu with "MENU" and "SEARCH" options. The main content area features a large image of a blue and white airplane in flight. To the left of the image, the text reads "Air Transportation Systems Laboratory at Virginia Tech". Below the image, there is a paragraph of text describing the laboratory's location and services.

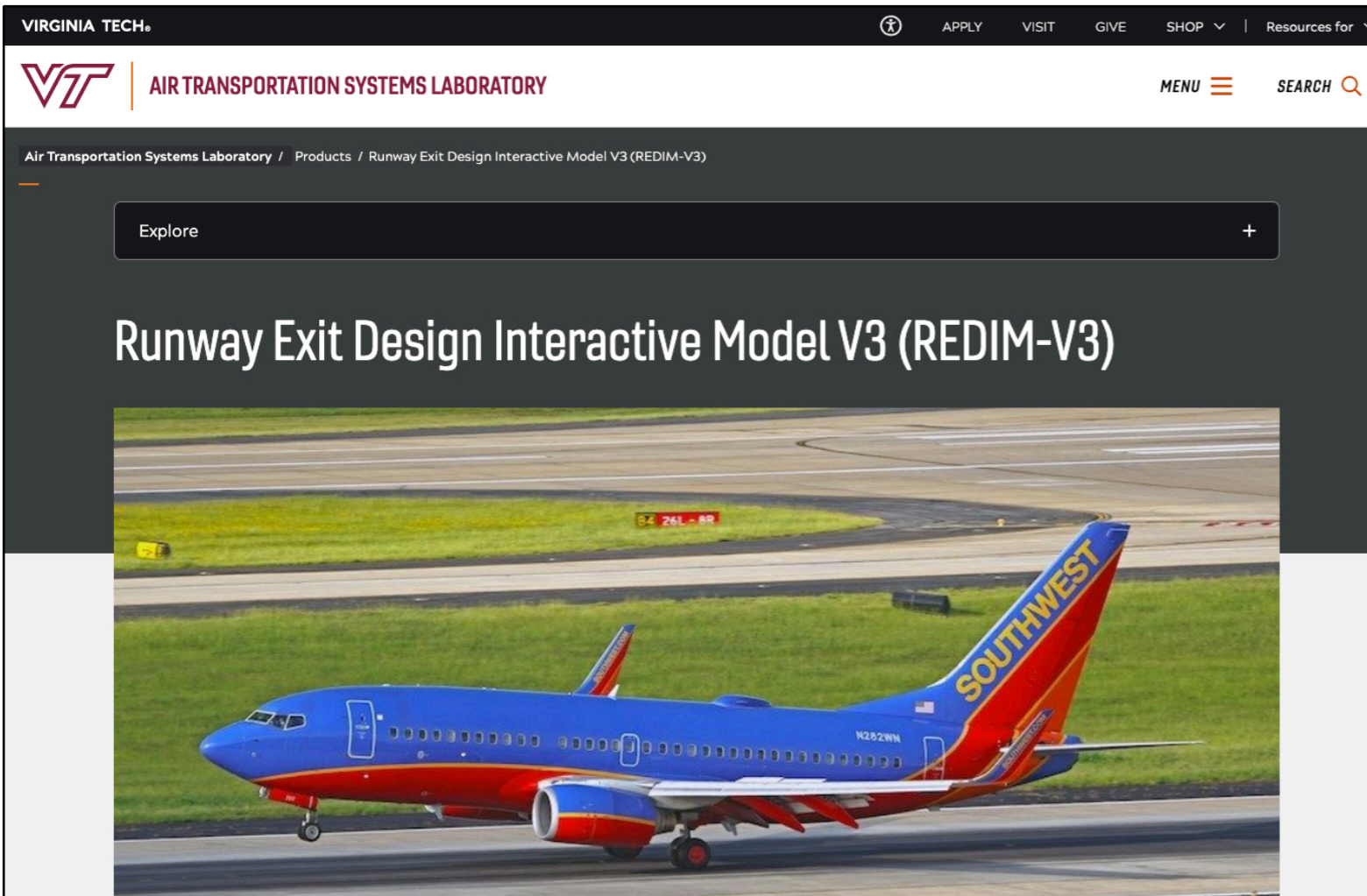
Air Transportation Systems Laboratory at Virginia Tech

The Air Transportation Systems Laboratory (ATSL) is located on the [Virginia Tech](#) campus and is part of the [Civil and Environmental Engineering](#) Department. The ATSL provides strong analytical capabilities of air transportation issues to its sponsors. The ATSL staff is comprised of professors, research scientists, research associates, post doctorates, doctoral students and master students.

<https://www.atsl.cee.vt.edu>



# Site to Obtain the Landing Events Database and Runway Exit Design Model



<https://atsl.cee.vt.edu/products/runway-exit-design-interactive-model--redim-.html>

## Download REDIM 3

- **REDIM 3.0.10** - Windows Installer
- **User Group**
- **User Manual**
- **FAQs**
- **Change Log**

## Download Landing Events Database

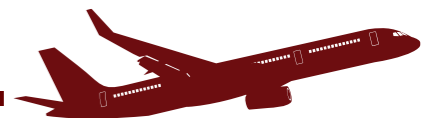
- **Landing Events Database 1.3.5** - Windows Installer
- **User Manual**

## Download REDIM 2

- **REDIM 2.1**

## Detailed Documentation for REDIM 3

- **Aircraft Database**
- **Runway Clusters**
- **Exit Clusters (Plots)**
- **Distributions:**
  - Threshold Crossing Speeds: **Aircraft - AAC**
  - Nose Gear Down Distances: **Aircraft - AAC**
  - Nominal Decelerations: **Aircraft - AAC**
  - Point Of Curvature (PC) Speeds: **Aircraft - AAC**
  - PC to Fuselage Out Decelerations: **Aircraft - AAC**
  - PC to Hold Bar Decelerations: **Aircraft - AAC**




# Landing Events Database





# Landing Events Database Updates/Improvements

- **Version 1.3.5 - released on November 19, 2021**
  - Filter results by airline (suggested at the last industry meeting)
  - Landing track follows the aircraft up to the last position reported (near the gate location)
  - Filter by date feature
  - Moved data to a new AWS service framework



## Landing Events Database

Version 1.3.5

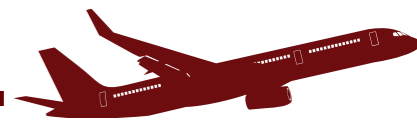
**Virginia Tech - Air Transportation Systems Lab**

Dr. Antonio Trani (Team Leader)	Mani Bhargava Reddy Bollempalli
Nicolas Hinze (Team Co-Leader)	Mihir Rimjha
Navid Mirmohammadsadeghi	Arman Izadi

**FAA - Project Sponsors**

Kent Duffy	FAA Airports Planning and Environmental Division (APP-400)
Lauren Vitagliano	FAA William J. Hughes Technical Center

For technical questions about this software please contact Nicolas Hinze ([nhinze@vt.edu](mailto:nhinze@vt.edu)) directly.



# Landing Events Database : Data Collection

- ASDE-X data
  - More than 32 million landing events
  - Years 2015-2020
- Runway exit geometry information for 4,806 runway exits at 313 runways (top 43 airports)
- One and 5-minute weather data for all 43 airports



Runway exit polygons at EWR airport



# Landing Event Database Tool Version 1.3.5



## Landing Events Database

Version 1.3.5

### Virginia Tech - Air Transportation Systems Lab

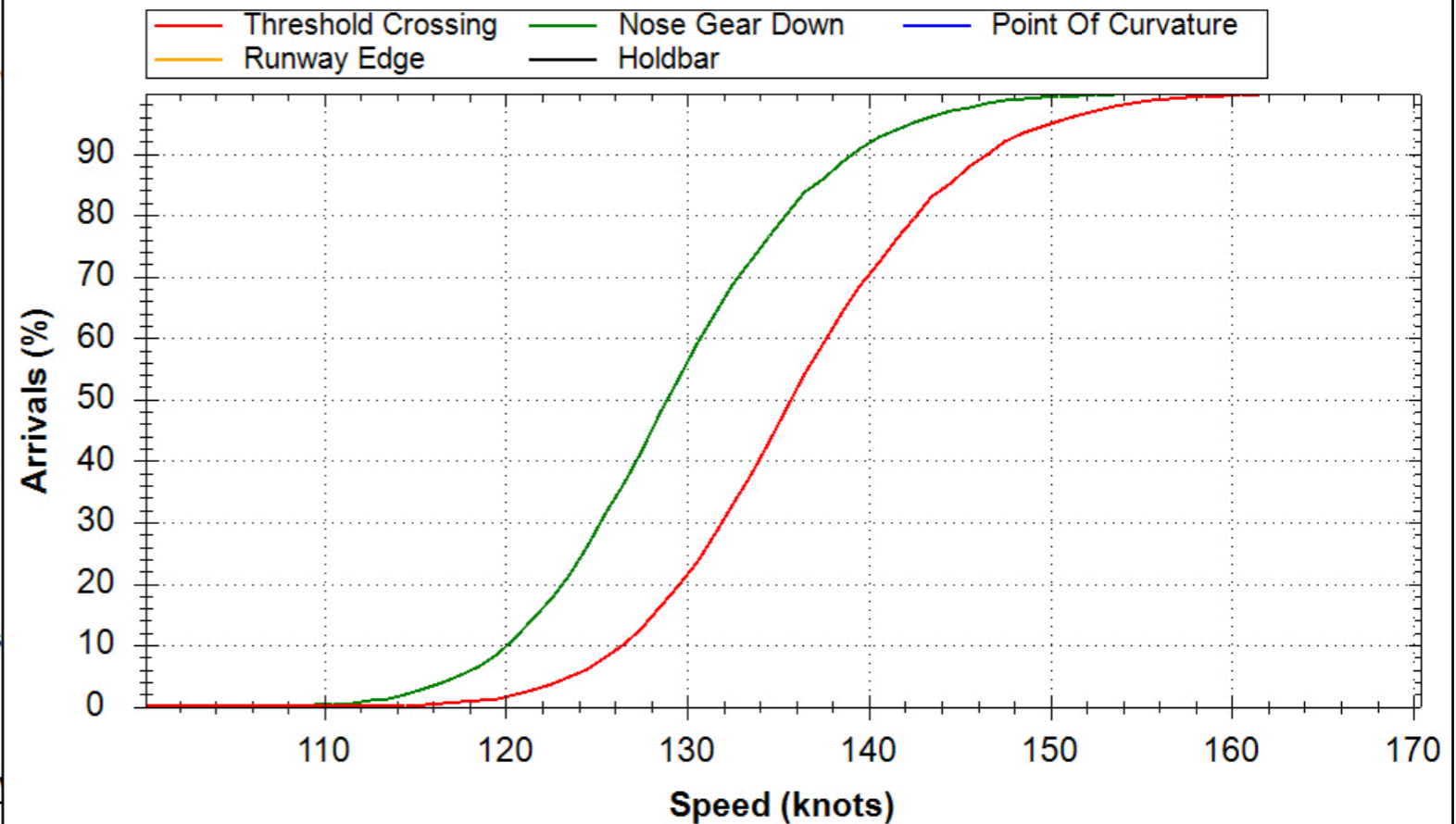
Dr. Antonio Trani (Team Leader)	Mani Bhargava Reddy
Nicolas Hinze (Team Co-Leader)	Mihir Rimjha
Navid Mirmohammadsadeghi	Arman Izadi

### FAA - Project Sponsors

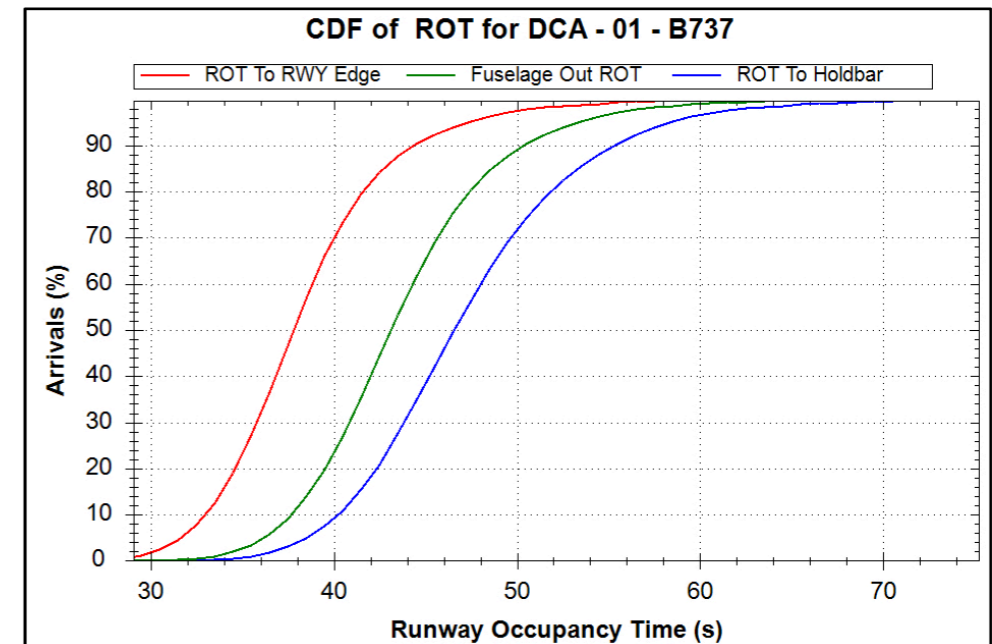
Kent Duffy	FAA Airports Planning and Environmental Divis
Lauren Vitagliano	FAA William J. Hughes Technical Center

For technical questions about this software please contact Nicolas Hinze (nhinze@)

CDF of Speed for DCA - 01 - A320



CDF of ROT for DCA - 01 - B737



Landing database client can be downloaded at:

<https://atsl.cee.vt.edu/products/runway-exit-design-interactive-model--redim-.html>

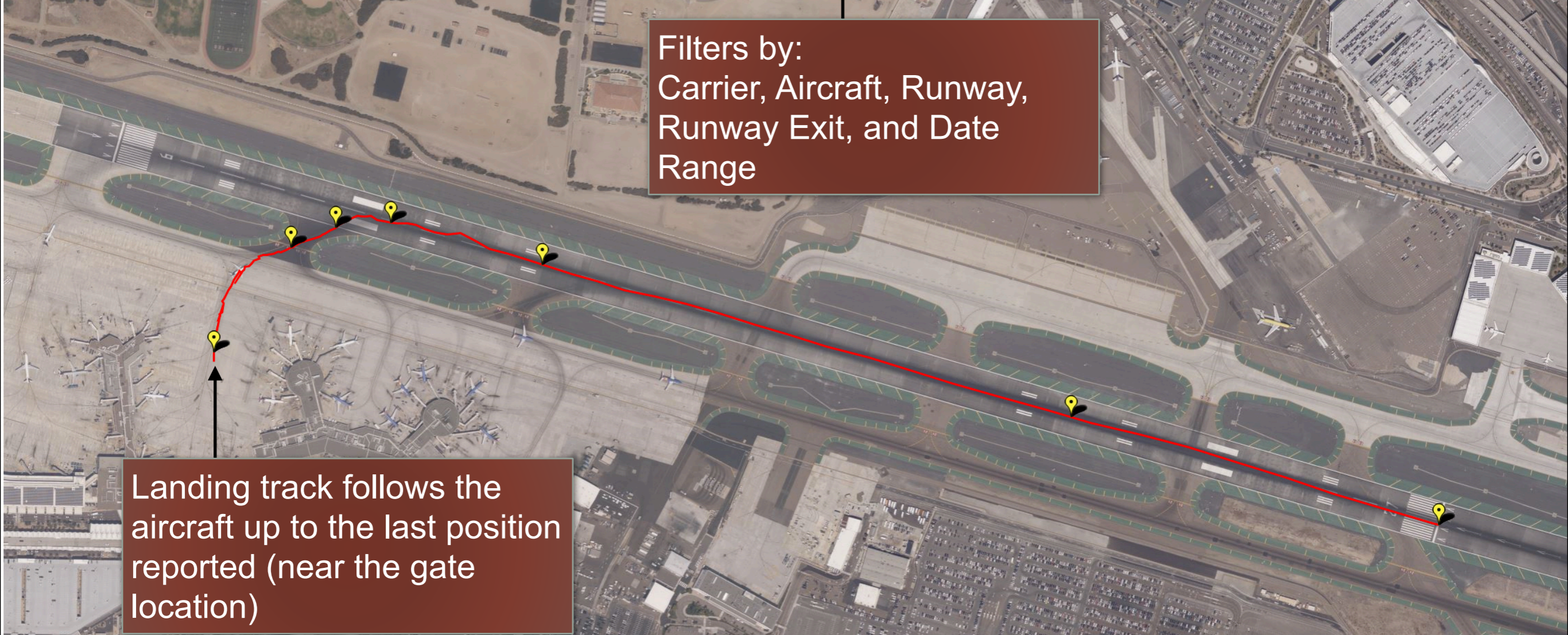


# Landing Event Database Tool Version 1.3.5

Runway: 27 Exit: Carrier: Aircraft: Arrival Valid Flights 11/ 1/2019 to 1/ 1/2021 Query Export

Flight ID	Carrier ID	Aircraft	Runway	Exit	Enter Time	Exit Time	Nose Gear Down (s)	Nose Gear Down (ft)	Nominal Speed Time (s)	Nominal Speed Distance (ft)	Point Of Curvature Time (s)	Point Of Curvature Distance (ft)	ROT Edge (s)	ROT Fuselage (s)	ROT Holdbar (s)
SCX403	SCX	B738	27	B8	11/1/2019 12:...	11/1/2019 1...	7.5	1,833	22.4	4,466	34.2	5,216	42.9	49.1	55.2
DAL989	DAL	A321	27	B9-1	11/1/2019 12:...	11/1/2019 1...	12.0	2,731	26.0	5,029	50.6	6,639	50.4	54.6	56.0
PCM7707	PCM	C208	27	C5	11/1/2019 12:...	11/1/2019 1...	6.7	828	16.1	1,734	22.9	2,162	30.3	32.5	35.7
SWA1473	SWA	B737	27	B8	11/1/2019 12:...	11/1/2019 1...	8.5	1,937	21.2	4,041	35.7	5,216	39.8	44.1	47.2
PWA120	PWA	C680	27	B7	11/1/2019 12:...	11/1/2019 1...	5.6	988	20.8	3,206	32.8	4,097	39.5	42.4	49.7
BAW44N	BAW	B744	27	B8	11/1/2019 12:...	11/1/2019 1...	9.4	2,188	20.6	4,025	40.6	5,216	50.7	61.7	59.2
SWA2866	SWA	B738	27	B8	11/1/2019 12:...	11/1/2019 1...	10.6	2,465	20.5	4,058	34.2	5,216	39.8	43.4	46.4

Map Speed vs Time Speed vs Distance Acceleration vs Time Acceleration vs Distance Data





# Landing Event Database Tool (1)

Analysis	Purpose	Metrics and Ready-Made Query Options
<b>Aircraft Mix</b>	Provides an overview of aircraft fleet mix in the form of a pie chart with the top 10 aircraft in the fleet mix presented.	By runway By runway exit
<b>Runway Occupancy Time</b>	Provides three values of runway occupancy time measured at three locations: 1.Runway edge 2.Fuselage out 3.At hold bar	1.Average ROT (in seconds) by runway, runway exit and aircraft 2.Median ROT (in seconds) by runway, runway exit and aircraft 3.Probability Density Function (PDF) of ROT (dim) by runway, runway exit and aircraft 4.Cumulative density function of ROT by runway, runway exit and aircraft 5.Runway exit utilization (percentage) by runway exit and aircraft
<b>Speed</b>	Provides information about five aircraft ground speeds at different locations of the landing profile: 1.Threshold 2.Nose gear down 3.Point of curvature 4.Runway edge 5.Hold bar	1.Average ROT (in seconds) by runway, runway exit and aircraft 2.Median ROT (in seconds) by runway, runway exit and aircraft 3.Probability Density Function (PDF) of ROT (dim) by runway, runway exit and aircraft 4.Cumulative density function of ROT by runway, runway exit and aircraft 5.Detailed speed profiles as a function of distance by aircraft, runway and runway exit 6.Detailed speed profiles as a function of time by aircraft, runway and runway exit
<b>Nose Gear Location</b>	Provides estimates of nose gear distance. The nose gear distance is estimated in the landing algorithm to initiate the nominal deceleration.	1.Nose gear distance from runway landing threshold by runway, aircraft and runway exit 2.Probability Density Function (PDF) of nose gear distance (feet or meters) by runway, runway exit and aircraft 3.Cumulative density function of nose gear distance (feet or meters) by runway, runway exit and aircraft



# Landing Event Database Tool (2)

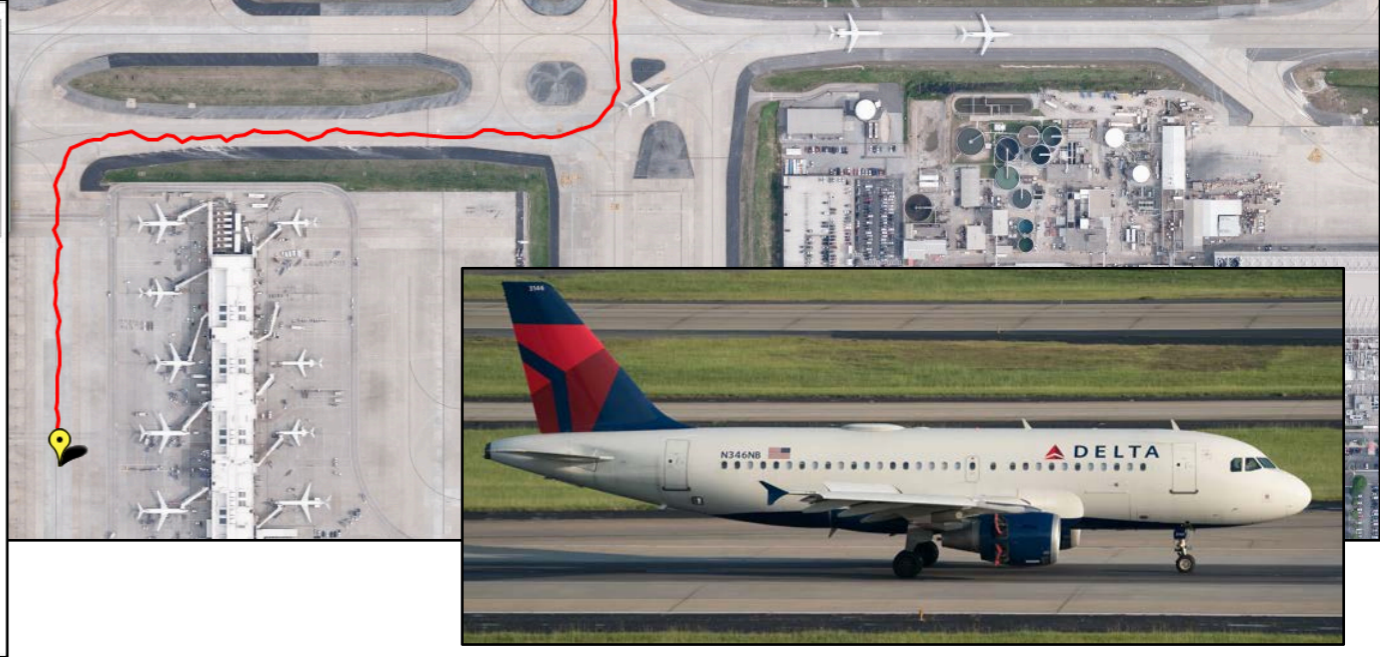
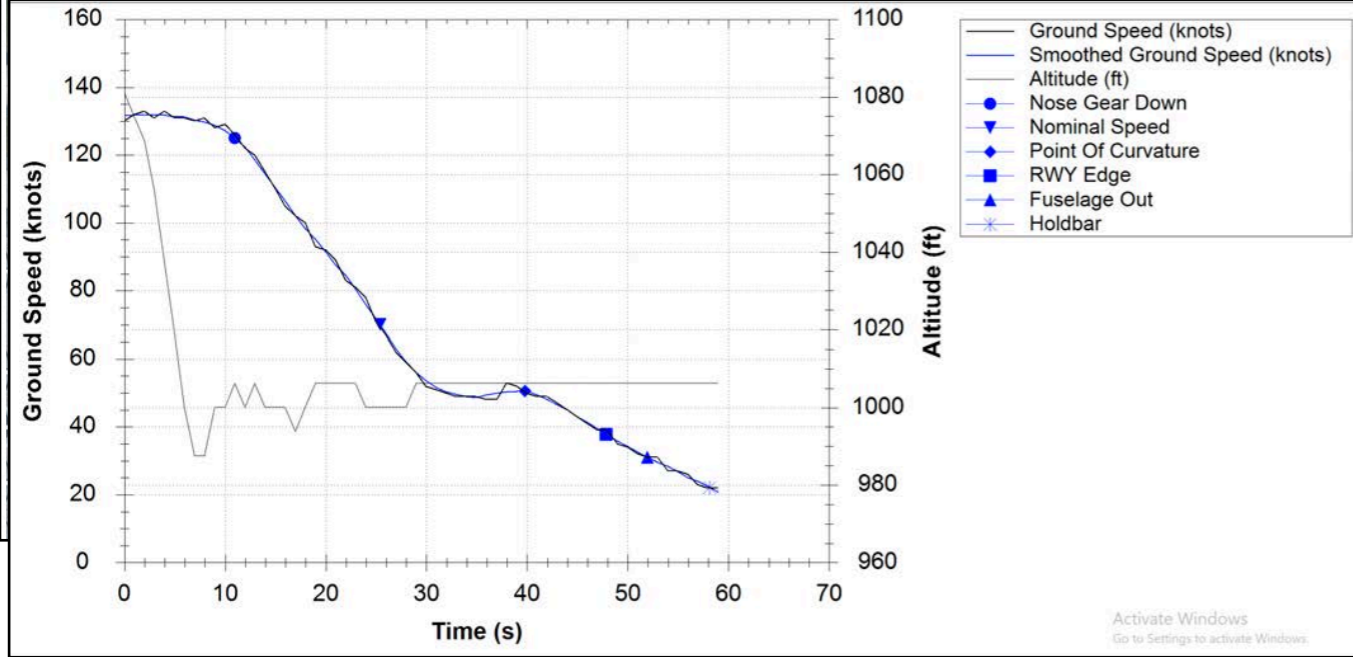
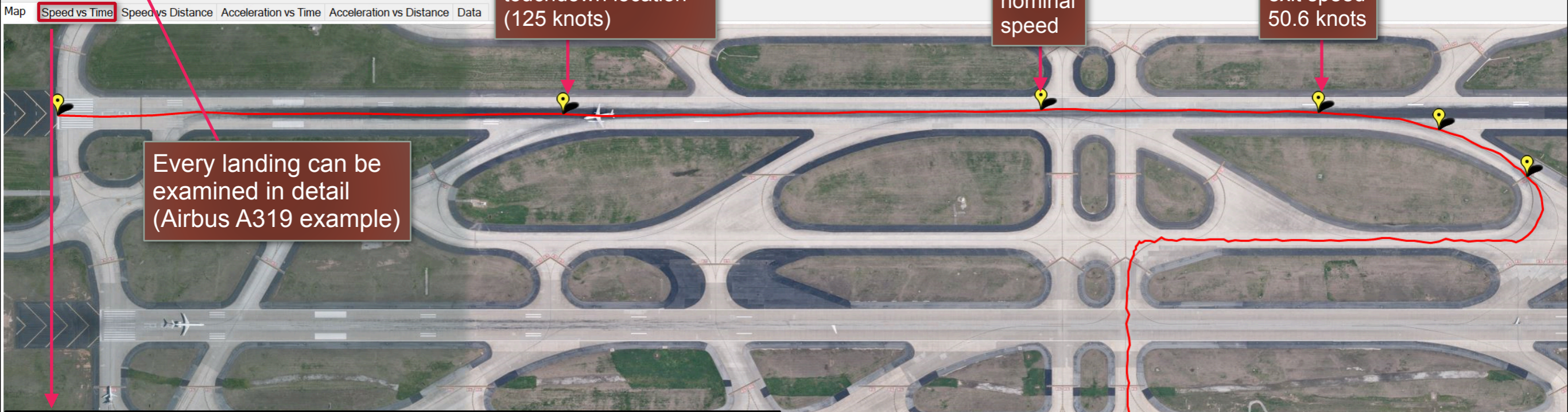
Analysis	Purpose	Metrics and Ready-Made Query Options
<b>Deceleration</b>	<p>Provides two values of aircraft deceleration on the runway:</p> <p>Nominal</p> <p>Nominal location to point of curvature (Nominal to PC)</p>	<p>Average deceleration (in m/s<sup>2</sup>) by runway, runway exit and aircraft</p> <p>Median deceleration (in m/s<sup>2</sup>) by runway, runway exit and aircraft</p> <p>Probability Density Function (PDF) of deceleration (in m/s<sup>2</sup>) by runway, runway exit and aircraft (both average and median values can be plotted)</p> <p>Cumulative density function of aircraft deceleration (in m/s<sup>2</sup>) by runway, runway exit and aircraft (both average and median values can be plotted)</p>
<b>Raw Data</b>	<p>Provides detailed information (in a table) on 30 key parameters for every landing contained in the Landing Events Database.</p> <p>Provides graphical information of every landing in the database.</p> <p>Provides a graphical depiction of individual landings in a Microsoft NAVTEQ map layer (bottom viewport)</p>	<p>30 key parameters defining the landing profile of each landing operation. Parameters include: flight ID, aircraft type, runway, runway exit use, time of operation, nose gear touchdown distance and time, nominal deceleration, deceleration from nominal point to PC, exit speed, and airport wind conditions.</p> <p>Speed-distance profile of each landing event</p> <p>Speed-time profile of each landing event</p> <p>Acceleration-time profile of each landing event</p> <p>Acceleration-distance profile of each landing event</p> <p>Processed numerical data with speed, acceleration, distance and time for individual landings.</p>
<b>Statistics</b>	<p>Summarizes the landing statistics processed by airport by month.</p>	<p>Total landing records</p> <p>Valid records</p> <p>Number of records with missing parameters</p> <p>Number of records with unreasonable parameters</p> <p>Records with no associated runway</p> <p>Go-around records</p>



# Landing Database Raw Data Viewer

Runway: 08L | Exit: | Carrier: DAL | Aircraft: A319 | Arrival: Valid Flights | 12/ 1/2019 | to | 1/ 1/2021 | Query | Export

Flight ID	Carrier ID	Aircraft	Runway	Exit	Enter Time	Exit Time	Nose Gear Down (s)	Nose Gear Down (ft)	Nominal Speed Time (s)	Nominal Speed Distance (ft)	Point Of Curvature Time (s)	Point Of Curvature Distance (ft)	ROT Edge (s)	ROT Fuselage (s)	ROT Holdbar (s)
DAL1351	DAL	A319	08L	B11	12/6/2019 2:2...	12/6/2019 2:...	11.0	2,390	25.4	4,650	39.8	5,965	47.9	52.0	58.1
DAL796	DAL	A319	08L	B11	12/7/2019 1:3...	12/7/2019 1:...	14.0	2,959	27.1	4,924	38.9	5,965	47.2	51.1	55.5
DAL1351	DAL	A319	08L	B11	12/7/2019 2:2...	12/7/2019 2:...	12.2	2,756	28.2	5,289	35.4	5,965	44.4	48.4	56.4
DAL796	DAL	A319	08L	B11	12/9/2019 1:3...	12/9/2019 1:...			27.7	4,961		5,965		48.7	54.0



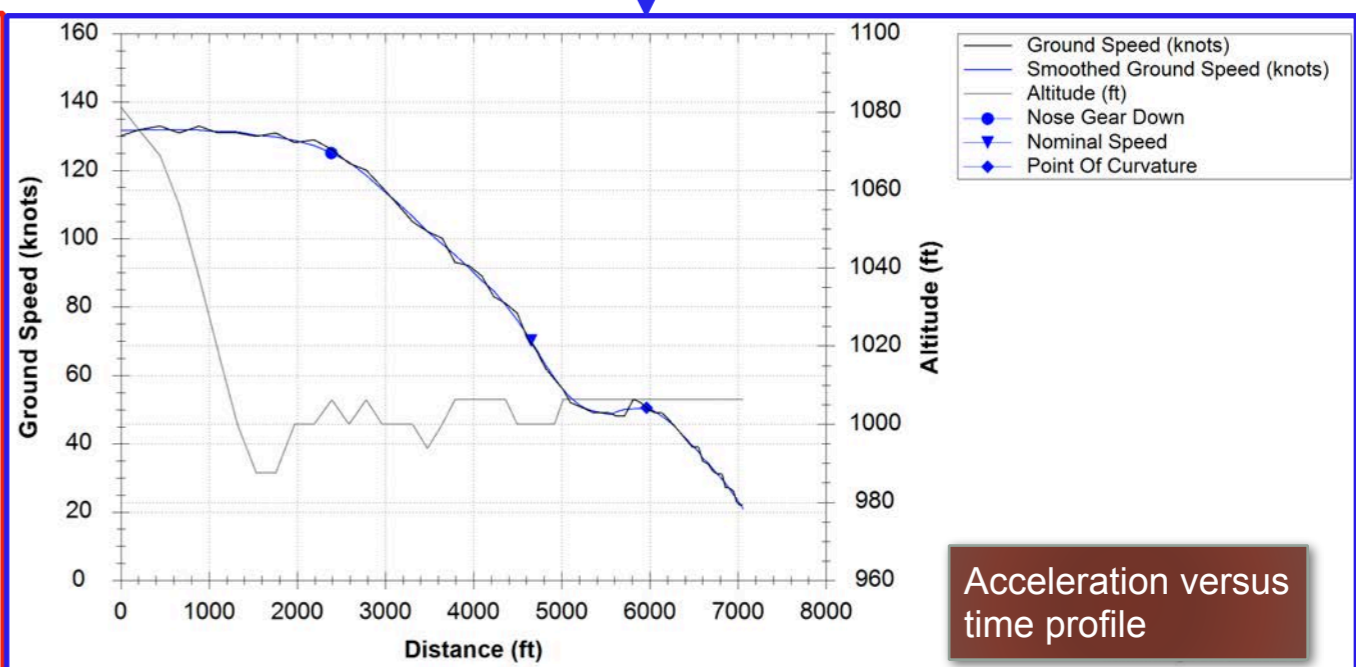
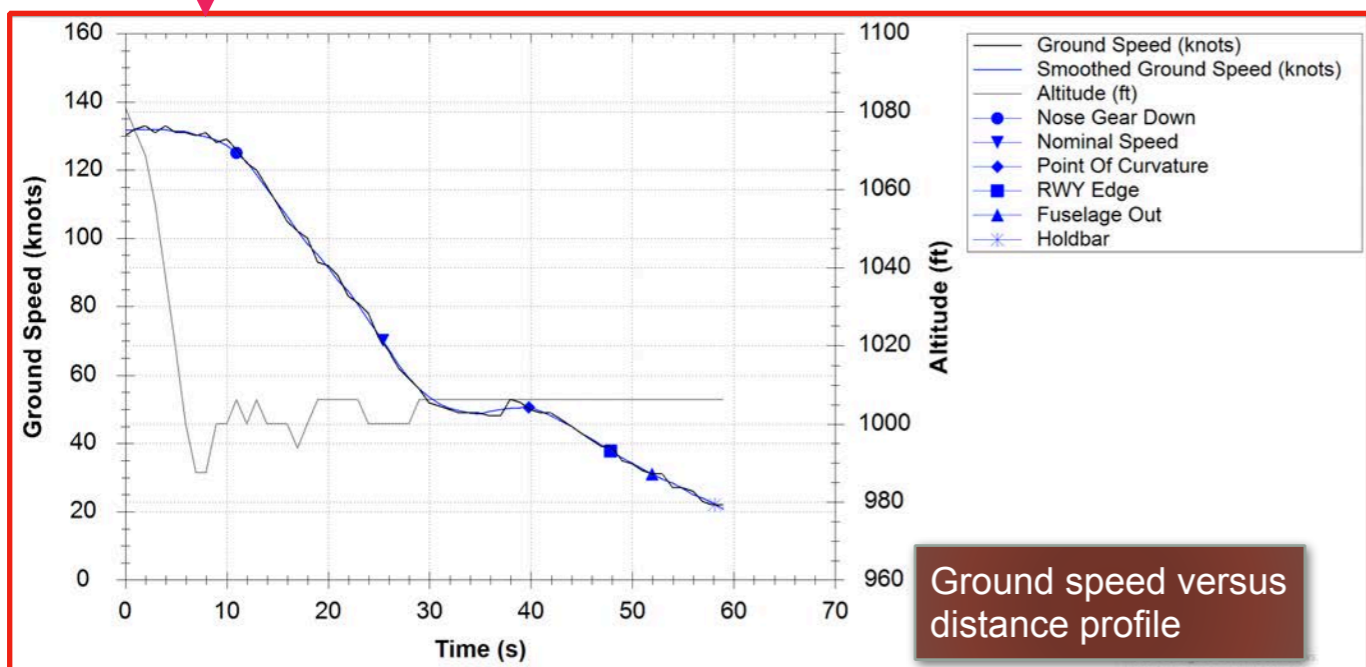


# Landing Database Raw Data Viewer

Runway: 08L    Exit:    Carrier: DAL    Aircraft: A319    Arrival    Valid Flights    12/ 1/2019    to    1/ 1/2021    Query    Export

	Nose Gear Down (ft)	Nominal Speed Time (s)	Nominal Speed Distance (ft)	Point Of Curvature Time (s)	Point Of Curvature Distance (ft)	ROT Edge (s)	ROT Fuselage (s)	ROT Holdbar (s)	Threshold Crossing Speed (kts)
	2,390	25.4	4,650	39.8	5,965	47.9	52.0	58.1	131.6
	2,959	27.1	4,924	38.9	5,965	47.2	51.1	55.5	125.8
	2,756	28.2	5,289	35.4	5,965	44.4	48.4	56.4	135.9
	2,589	27.7	4,961	37.4	5,965	44.8	48.7	54.0	128.4

Map    **Speed vs Time**    Speed vs Distance    Acceleration vs Time    Acceleration vs Distance    Data





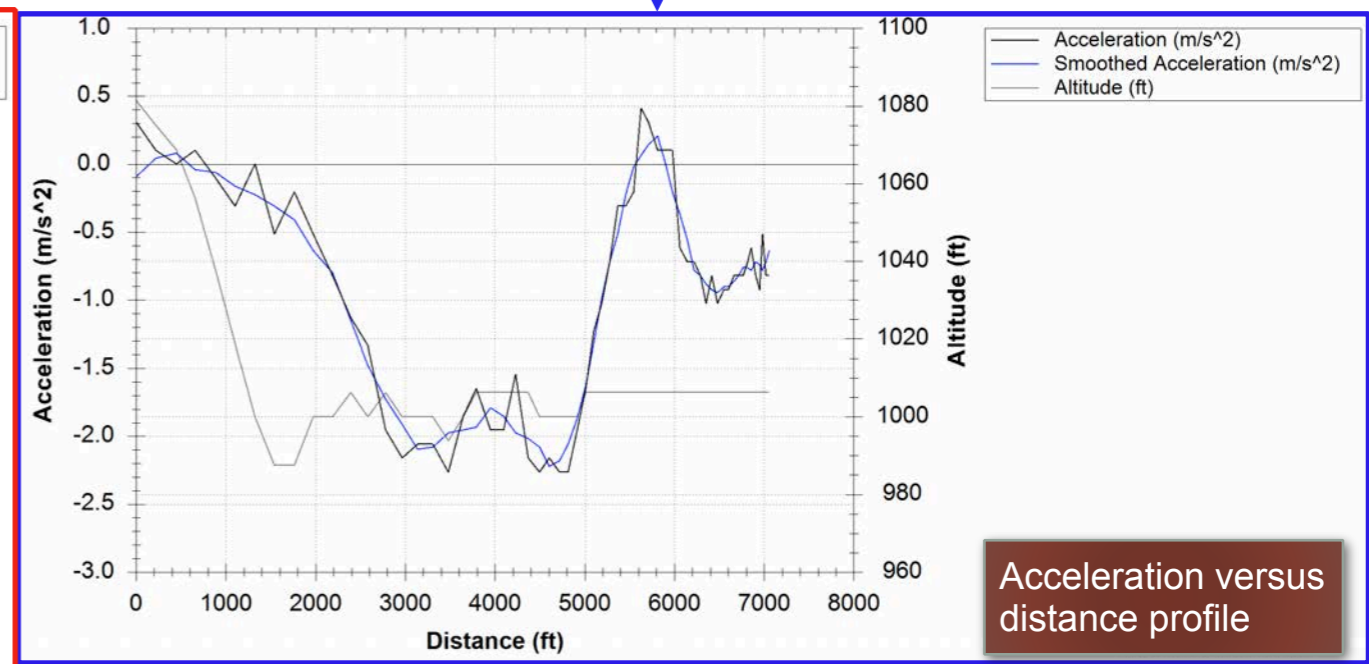
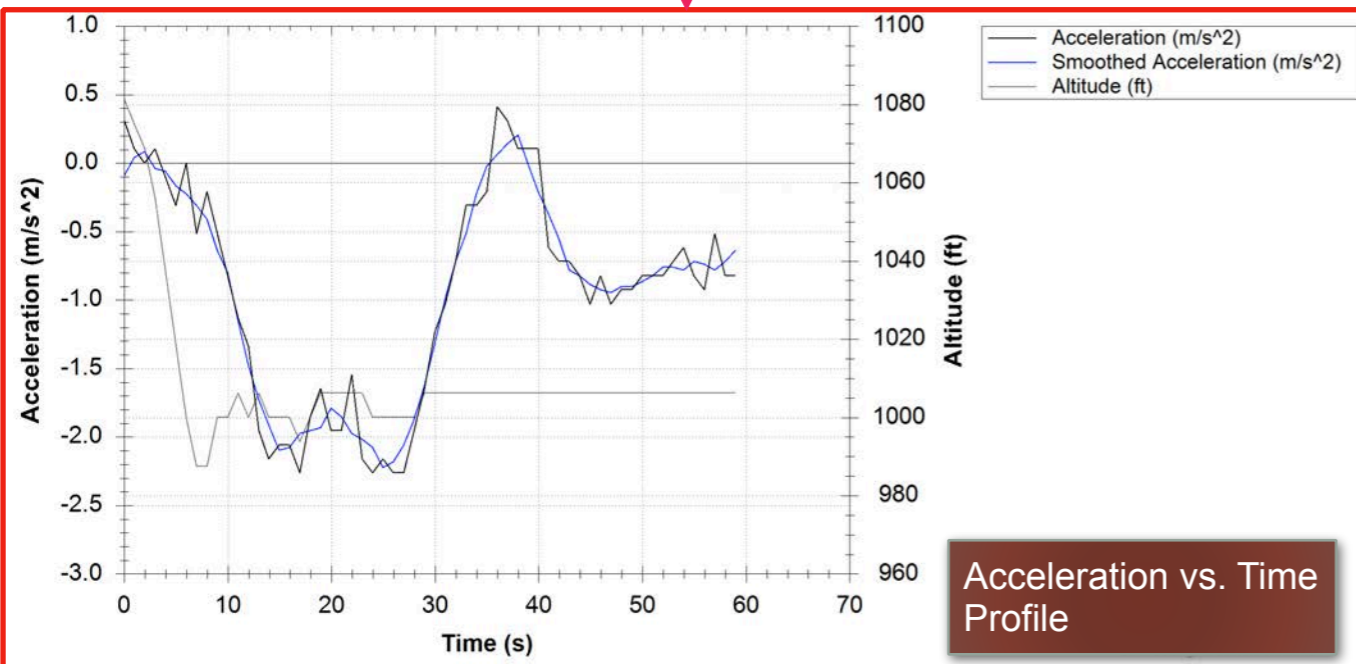


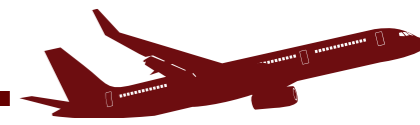
# Landing Database Raw Data Viewer

Runway: 08L Exit: Carrier: DAL Aircraft: A319 Arrival Valid Flights 12/ 1/2019 to 1/ 1/2021 Query Export

	Nose Gear Down (ft)	Nominal Speed Time (s)	Nominal Speed Distance (ft)	Point Of Curvature Time (s)	Point Of Curvature Distance (ft)	ROT Edge (s)	ROT Fuselage (s)	ROT Holdbar (s)	Threshold Crossing Speed (kts)
	2,390	25.4	4,650	39.8	5,965	47.9	52.0	58.1	131.6
	2,959	27.1	4,924	38.9	5,965	47.2	51.1	55.5	125.8
	2,756	28.2	5,289	35.4	5,965	44.4	48.4	56.4	135.9
	2,589	27.7	4,961	37.4	5,965	44.8	48.7	54.0	128.4

Map Speed vs Time Speed vs Distance Acceleration vs Time Acceleration vs Distance Data





# Landing Database Raw Data Viewer

Runway: 08L Exit: Carrier: DAL Aircraft: A319 Arrival Valid Flights 12/ 1/2019 to 1/ 1/2021 Query Export

	Nose Gear Down (ft)	Nominal Speed Time (s)	Nominal Speed Distance (ft)	Point Of Curvature Time (s)	Point Of Curvature Distance (ft)	ROT Edge (s)	ROT Fuselage (s)	ROT Holdbar (s)	Threshold Crossing Speed (kts)
	2,390	25.4	4,650	39.8	5,965	47.9	52.0	58.1	131.6
	2,959	27.1	4,924	38.9	5,965	47.2	51.1	55.5	125.8
	2,756	28.2	5,289	35.4	5,965	44.4	48.4	56.4	135.9
	2,589	27.7	4,961	37.4	5,965	44.8	48.7	54.0	128.4

Map Speed vs Time Speed vs Distance Acceleration vs Time Acceleration vs Distance **Data**

All data

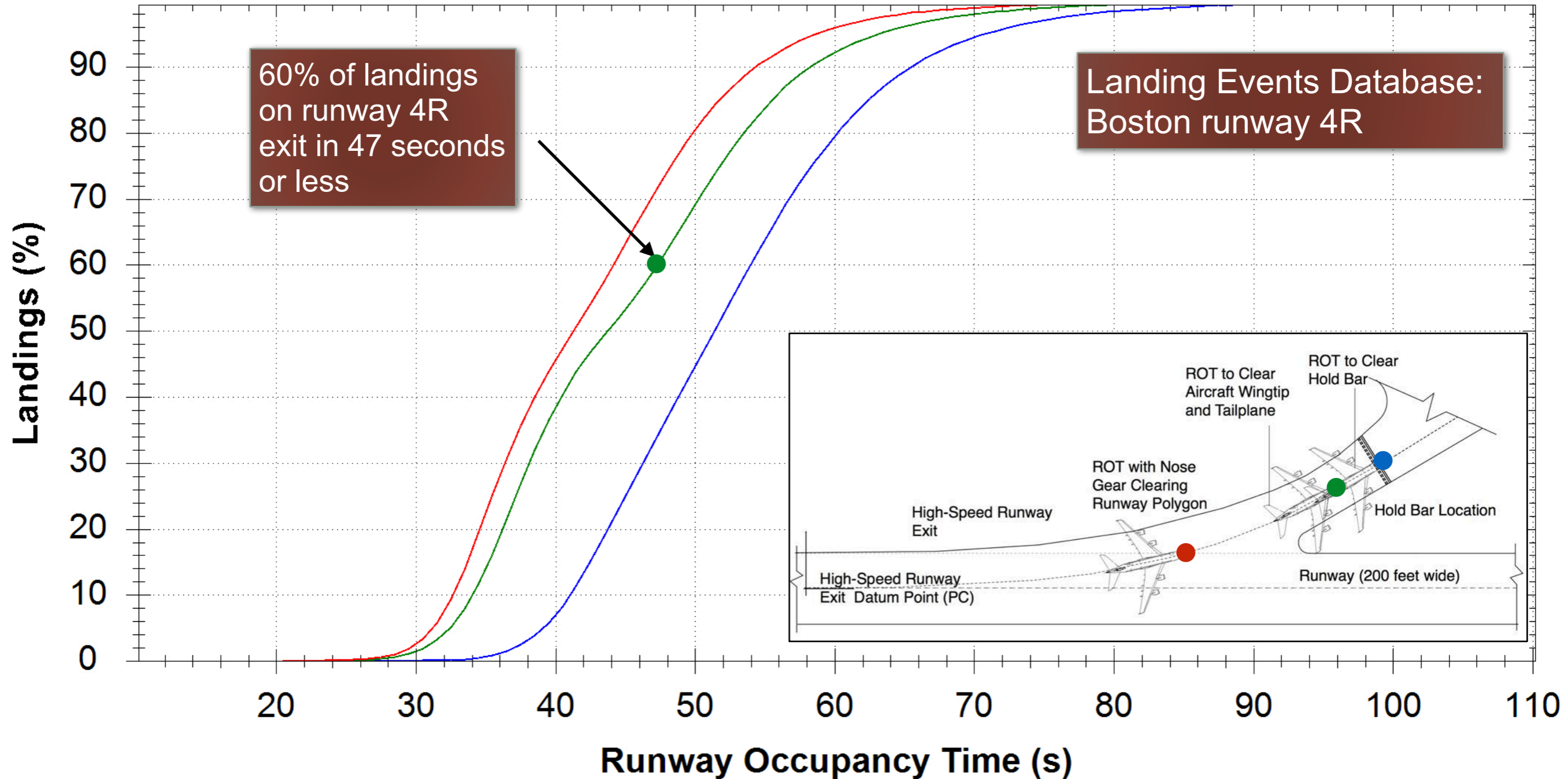
Time (s)	Speed (kts)	Smoothed Speed (kts)	Distance (ft)	Acceleration (m/s <sup>2</sup> )	Smoothed Acceleration (m/s <sup>2</sup> )	Altitude (ft)	Point ID
0.0	130.1	131.6	0	0.3	-0.1	1,081	192
1.0	132.0	131.8	219	0.1	0.0	1,075	193
2.0	133.0	131.8	447	0.0	0.1	1,069	194
3.0	131.0	132.0	660	0.1	0.0	1,056	195
4.0	133.0	131.8	887	-0.1	-0.1	1,038	196
5.0	131.0	131.2	1,105	-0.3	-0.2	1,019	197
6.0	131.0	131.2	1,325	0.0	-0.2	1,000	198
7.0	130.0	130.2	1,539	-0.5	-0.3	988	199
8.0	131.0	129.8	1,761	-0.2	-0.4	988	200
9.0	128.0	128.8	1,971	-0.5	-0.6	1,000	201
10.0	129.0	127.2	2,192	-0.8	-0.8	1,000	202
11.0	126.0	125.0	2,393	-1.1	-1.2	1,006	203
12.0	122.0	122.4	2,587	-1.3	-1.5	1,000	204
13.0	120.0	118.6	2,784	-2.0	-1.7	1,006	205
14.0	115.0	114.4	2,965	-2.2	-1.9	1,000	206
15.0	110.0	110.4	3,139	-2.1	-2.1	1,000	207
16.0	105.0	106.4	3,310	-2.1	-2.1	1,000	208
17.0	102.0	102.0	3,479	-2.3	-2.0	994	209
18.0	100.0	98.4	3,647	-1.9	-2.0	1,000	210
19.0	93.0	95.2	3,793	-1.6	-1.9	1,006	211



# Runway Occupancy Time Information

## CDF of ROT for BOS - 04R

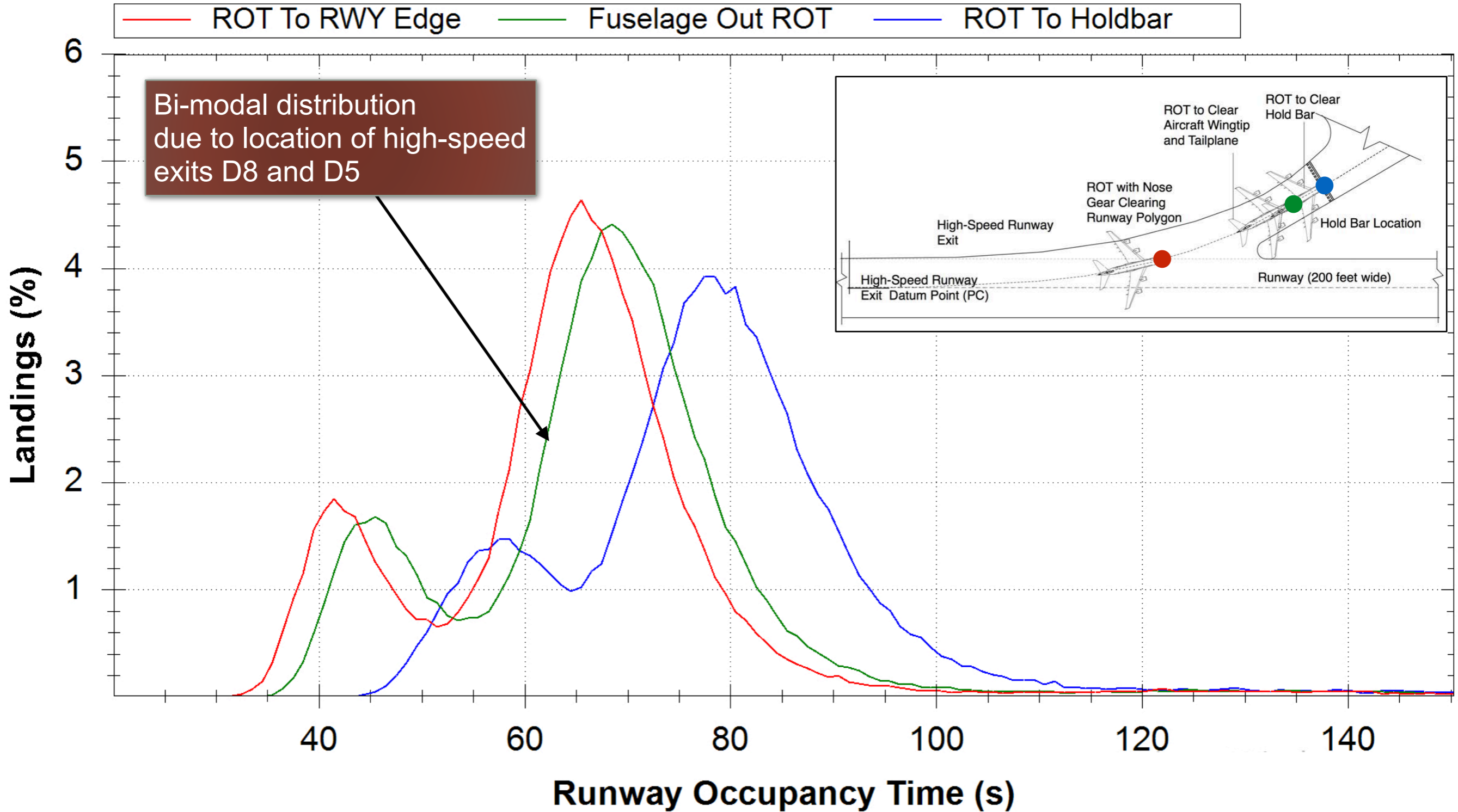
— ROT To RWY Edge    — Fuselage Out ROT    — ROT To Holdbar

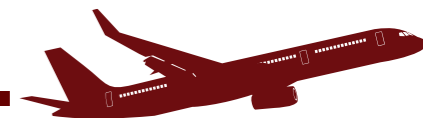




# Distribution of Runway Occupancy Times

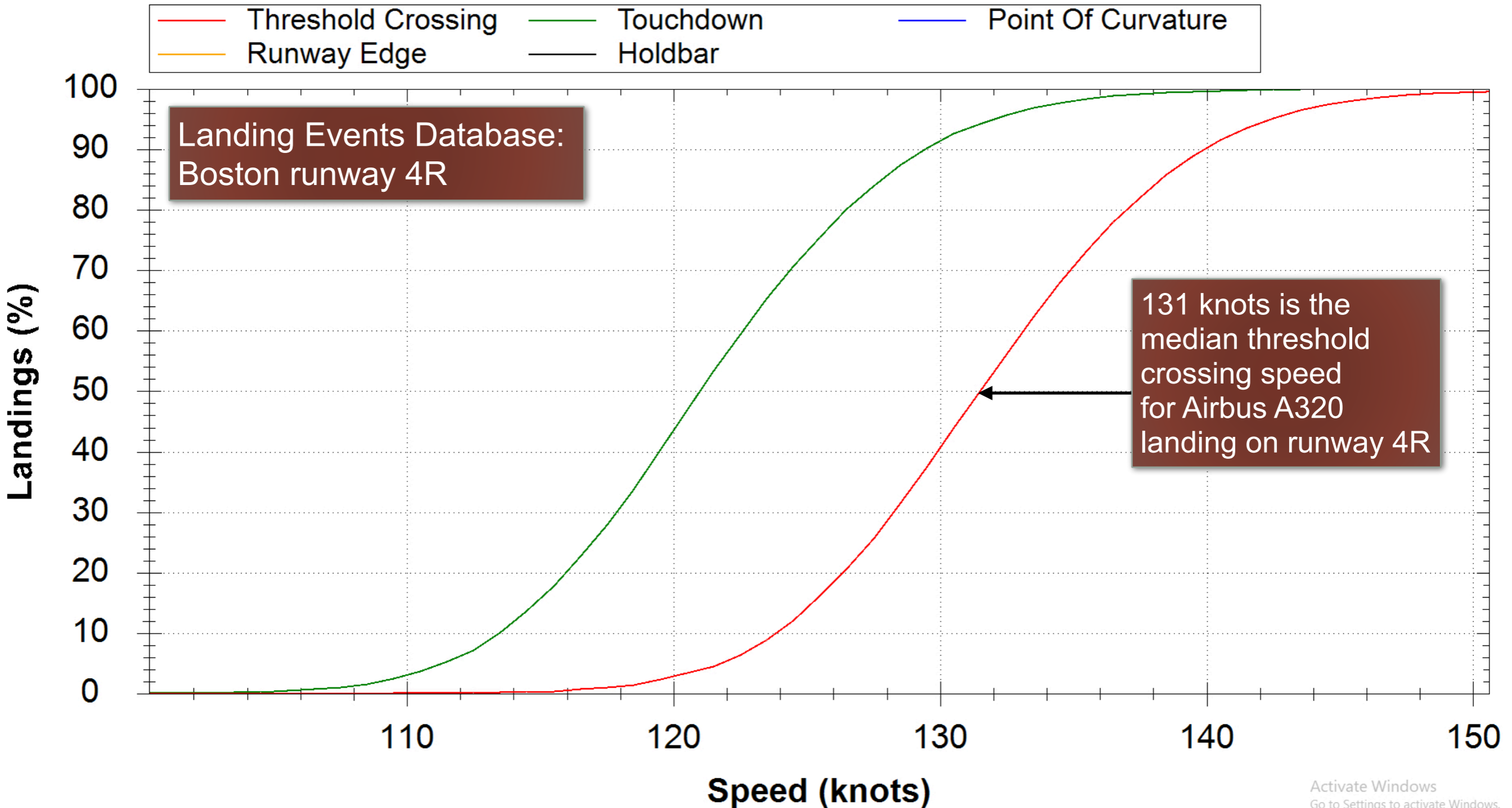
## PDF of ROT for DEN - 16R





# Ground Speed Distribution Over Runway Threshold

## CDF of Speed for BOS - 04R - A320



Activate Windows  
Go to Settings to activate Windows.



# Runway Occupancy Time Tables

**Step 1**  
Runway  
Occupancy Time

**Step 2**  
Select runway

**Step 3**  
Select ROT Table  
1) ROT to runway edge  
2) ROT to clear runway  
3) ROT to hold bar

**Step 4**  
Plot (query)

Landing Events Database

ATL - Runway Occupancy Time (ROT) Analysis

Runway: 08L | ROT Type: Fuselage Out | Query

By Aircraft | Distribution | Table

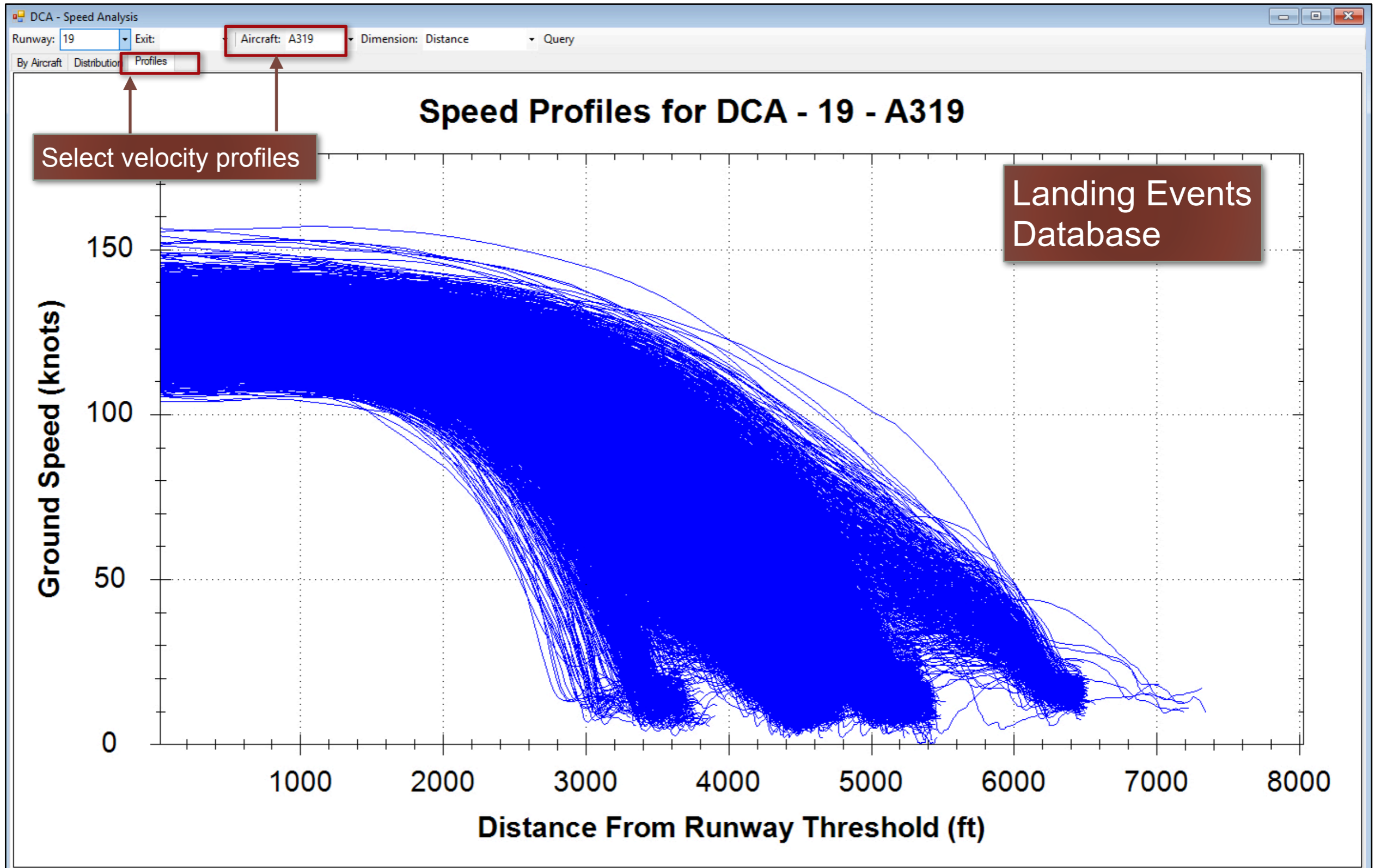
### Fuselage Out ROT for ATL - 08L

Aircraft	A	A4	A6-1	A6-2	B11	B13	B15	B5	B7	C-L	C-R	D-L	D-R	Average
A124						114.2s 100.0%								114.2s
A306	90.0s 3.0%		62.2s 33.3%	61.8s 53.3%	44.5s 0.3%					47.6s 2.0%		52.7s 8.1%		61.7s
A310			62.5s 45.5%	60.6s 34.1%						49.2s 2.3%				
A319	75.6s 0.0%			59.8s 0.2%	50.5s 77.3%	71.2s 1.2%	78.7s 0.0%	36.2s 0.0%	41.3s 14.9%	47.6s 0.0%				
A320	81.9s 0.0%			54.4s 0.1%	48.7s 89.4%	70.3s 3.1%	69.3s 0.1%		40.6s 5.0%					
A321	83.0s 0.1%		57.3s 0.1%	53.8s 0.3%	47.8s 81.3%	69.4s 14.2%	75.7s 0.4%		39.8s 3.0%					
A332					56.2s 77.8%	78.3s 20.4%	72.1s 1.9%							
A333					54.0s 81.1%	75.0s 16.3%	80.8s 1.1%		48.4s 0.8%					
A343					56.3s 67.1%	79.1s 30.4%	82.1s 1.3%		49.8s 1.3%					
A346					54.5s 71.6%	80.0s 28.4%								
AC50										55.0s 10.0%				
AC90										46.0s 10.0%				
AC95										59.0s 10.0%				
AEST				68.3s 16.7%						70.3s 33.3%		69.8s 50.0%		69.7s
ASTR				53.1s 31.3%						43.4s 18.8%		45.8s 50.0%		47.6s
AT43		34.1s 16.7%								47.1s 16.7%		51.8s 66.7%		48.1s
AT72										44.1s 50.0%		49.0s 50.0%		46.5s
B190				61.1s 0.4%						47.2s 53.6%		50.2s 45.9%		48.7s
B350		38.0s 8.8%								50.5s 59.3%		53.5s 31.9%		50.3s
B712	72.0s 0.0%			48.1s 0.1%	46.3s 94.6%	66.6s 0.8%	65.9s 0.0%		38.8s 3.7%		40.6s 0.2%		42.8s 0.6%	46.2s
B732				51.1s 100.0%										51.1s
B733				53.9s 0.1%	47.7s 68.9%	67.7s 0.4%		39.5s 20.7%		41.6s 3.1%	45.8s 0.1%	43.0s 6.8%		45.6s
B734	70.6s 5.1%			52.2s 79.5%	51.5s 1.7%	71.7s 0.9%	78.3s 0.9%			43.2s 3.4%		45.8s 8.5%		52.7s
B735				55.6s 33.3%	48.6s 33.3%								43.1s 33.3%	49.1s

Cells in table show:  
1) Average runway occupancy time by runway exit at the selected runway  
2) Percent of aircraft using each runway exit



# Aircraft Velocity Profiles : Airbus A319 at DCA Runway 19

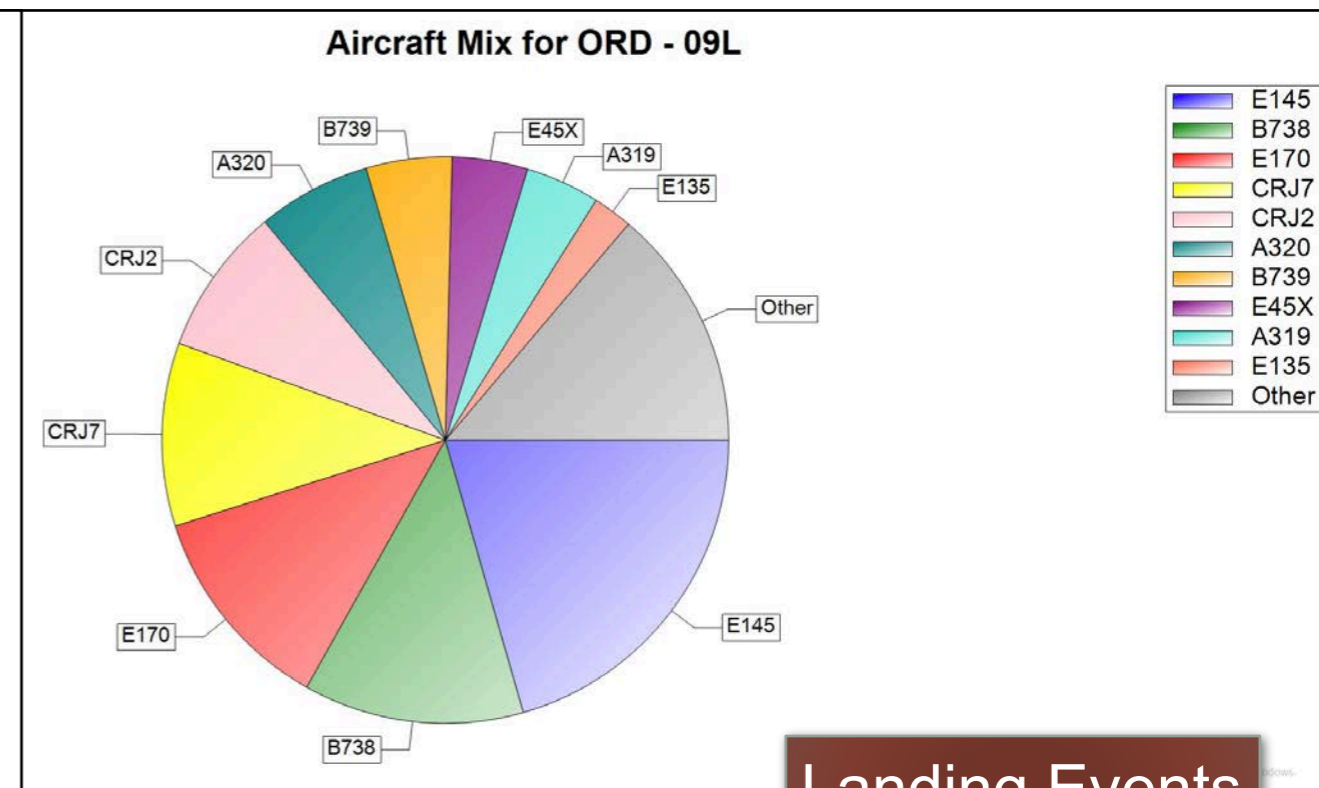
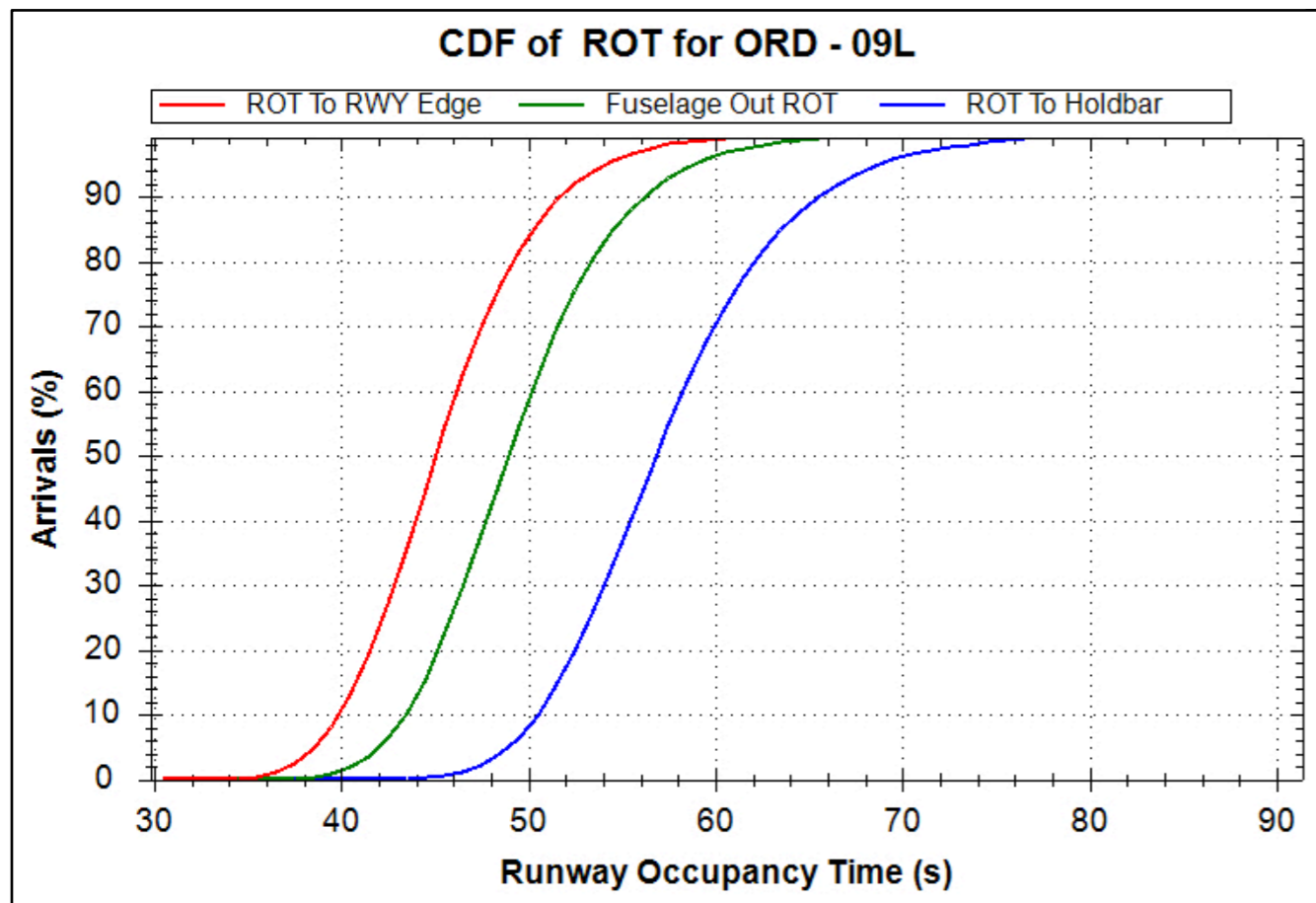




# ORD Airport Runway 9L (Two Usable Exits)

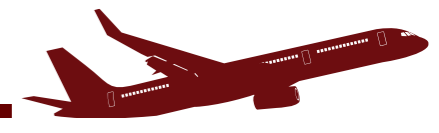


At runway exit holdbar  
50th percentile ROT is 56 seconds  
95th percentile ROT is 71 seconds  
Relatively high ROT value due to few runway exits



Landing Events Database

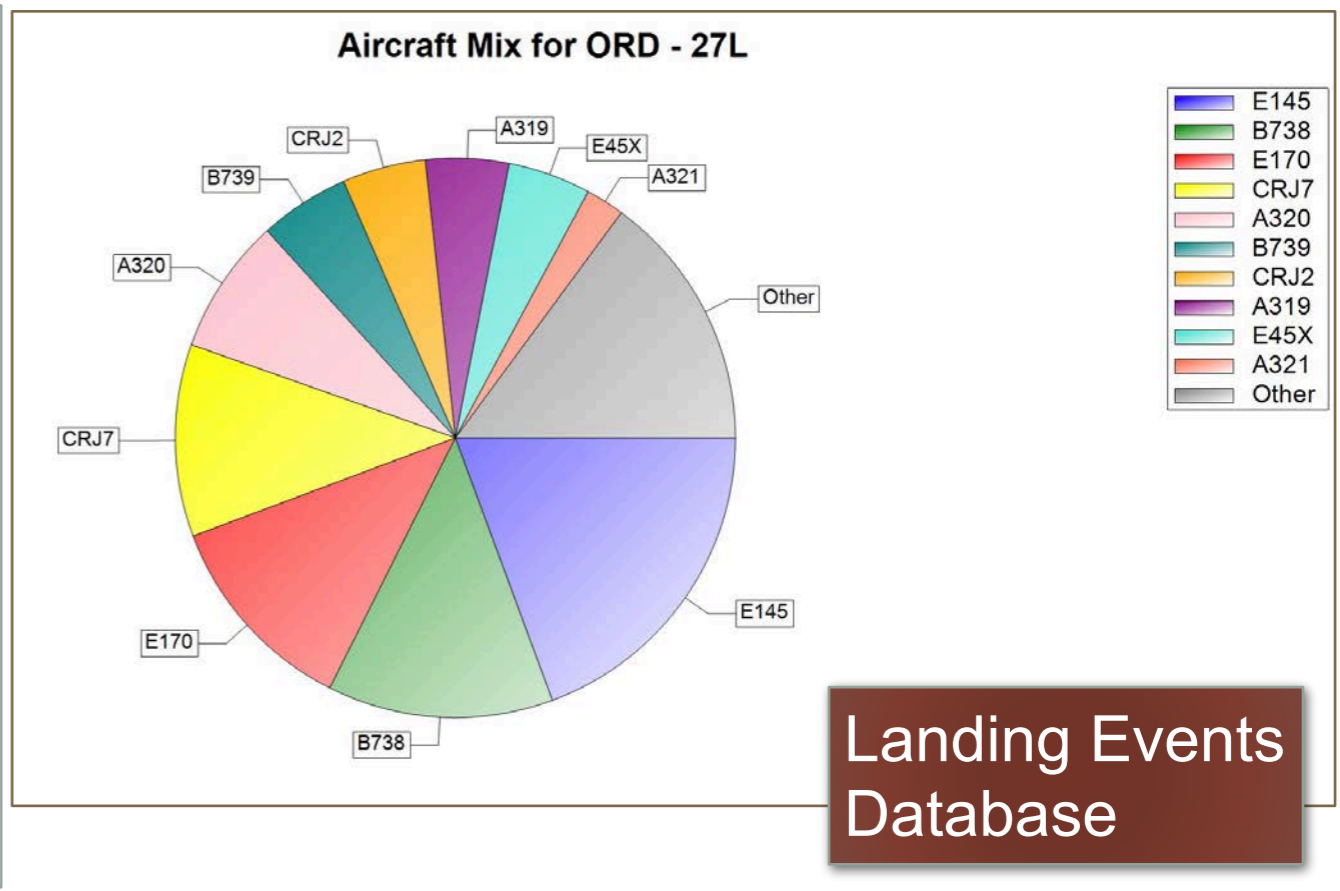
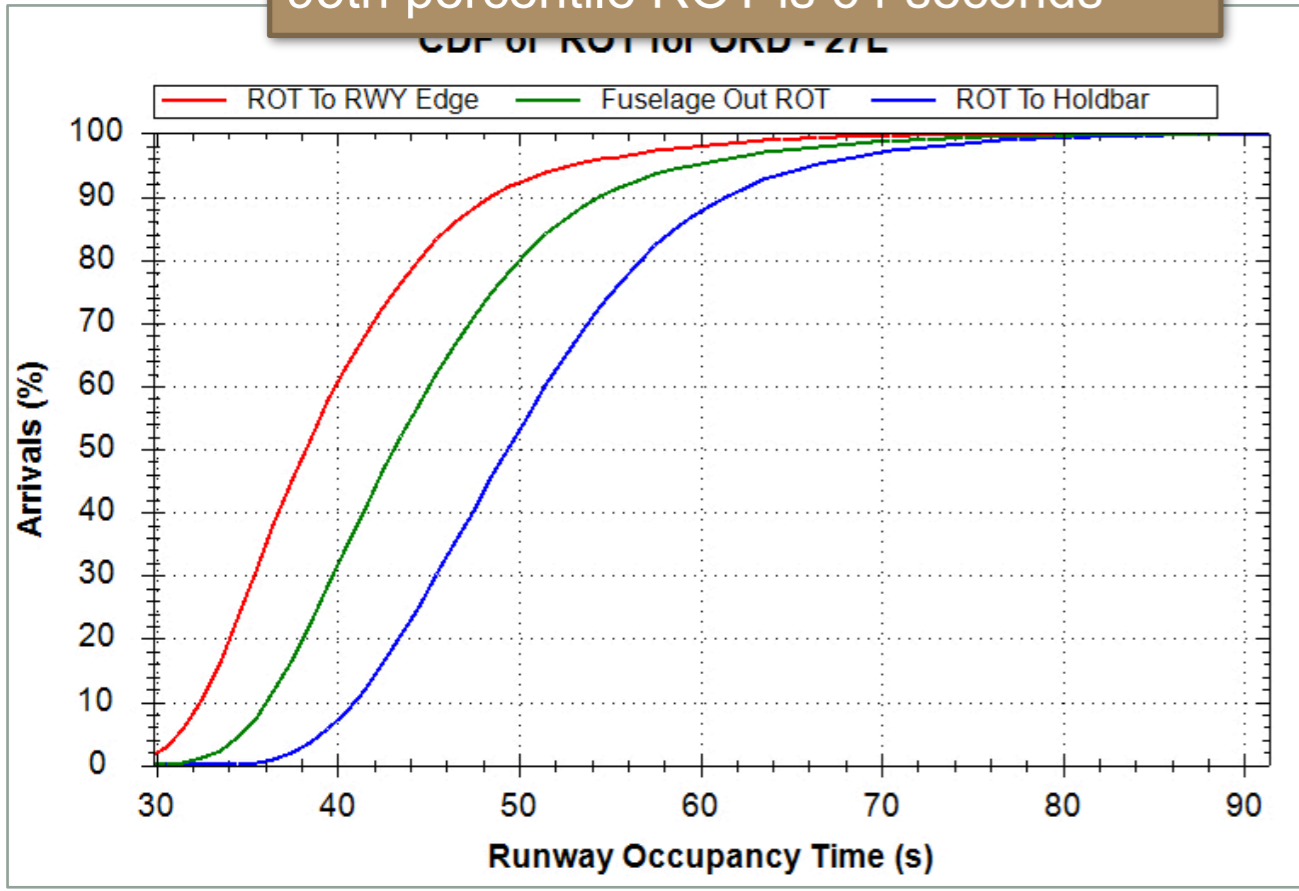




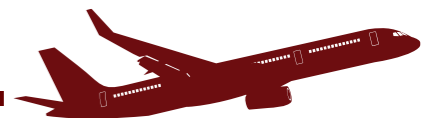
# ORD Airport Runway 27L (Five Usable Exits)



At runway exit holdbar  
50th percentile ROT is 49 seconds  
95th percentile ROT is 64 seconds



Landing Events Database



# Runway Exit Design Tool (REDIM Model)



# Runway Exit Design Tool (REDIM 3 Model)



## REDIM

Version 3.0.10

### Virginia Tech - Air Transportation Systems Lab

Dr. Antonio Trani (Team Leader)  
Nicolas Hinze (Team Co-Leader)  
Navid Mirmohammadsadeghi

Mani Bhargava Reddy Bollempalli  
Mihir Rimjha  
Arman Izadi

### FAA - Project Sponsors

Kent Duffy  
Lauren Vitagliano

FAA Airports Planning and Environmental Division (APP-400)  
FAA William J. Hughes Technical Center

## Download REDIM 3

- [REDIM 3.0.10](#) - Windows Installer
- [User Group](#)
- [User Manual](#)
- [FAQs](#)
- [Change Log](#)

## Download Landing Events Database

- [Landing Events Database 1.3.5](#) - Windows Installer
- [User Manual](#)

## Download REDIM 2

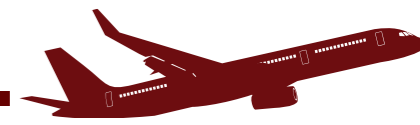
- [REDIM 2.1](#)

## Detailed Documentation for REDIM 3

- [Aircraft Database](#)
- [Runway Clusters](#)
- [Exit Clusters \(Plots\)](#)
- Distributions:
  - Threshold Crossing Speeds: [Aircraft](#) - [AAC](#)
  - Nose Gear Down Distances: [Aircraft](#) - [AAC](#)
  - Nominal Decelerations: [Aircraft](#) - [AAC](#)
  - Point Of Curvature (PC) Speeds: [Aircraft](#) - [AAC](#)
  - PC to Fuselage Out Decelerations: [Aircraft](#) - [AAC](#)
  - PC to Hold Bar Decelerations: [Aircraft](#) - [AAC](#)

The Runway Exit Design Tool can be downloaded at:

<https://atsl.cee.vt.edu/products/runway-exit-design-interactive-model--redim-.html>



# New version REDIM 4.0



## REDIM

Version 4.0.0.alpha2 - Date: 02/22/2022

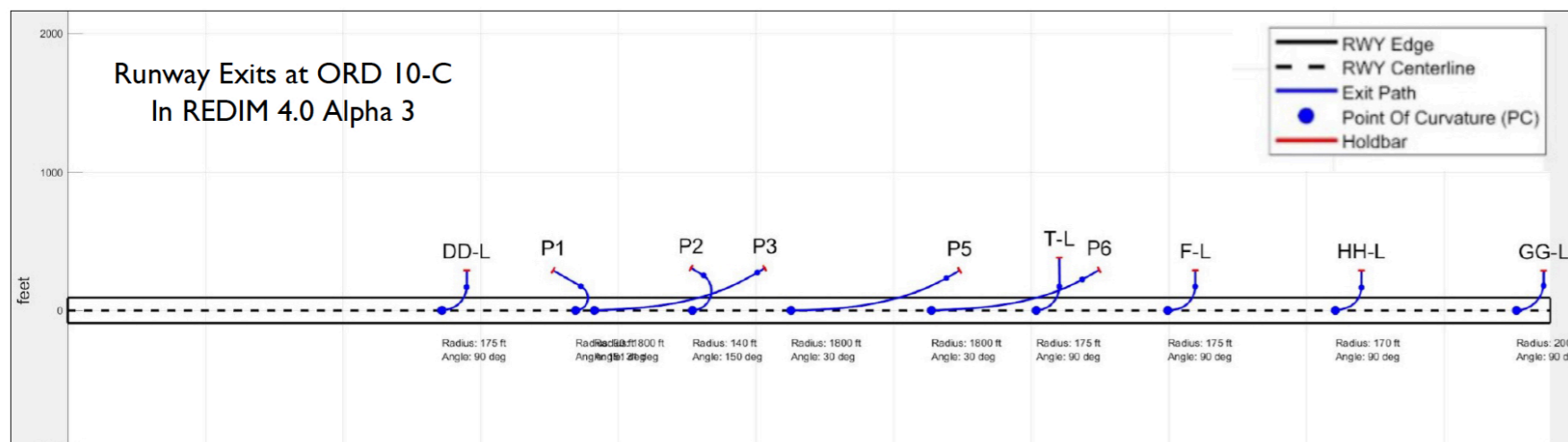
### Virginia Tech - Air Transportation Systems Lab

Dr. Antonio Trani (Team Leader)	Mani Bhargava Reddy Bollempalli
Nicolas Hinze (Team Co-Leader)	Mihir Rimjha
Navid Mirmohammadsadeghi	Arman Izadi

### FAA - Project Sponsors

Kent Duffy	FAA Airports Planning and Environmental Division (APP-400)
Lauren Vitagliano	FAA William J. Hughes Technical Center

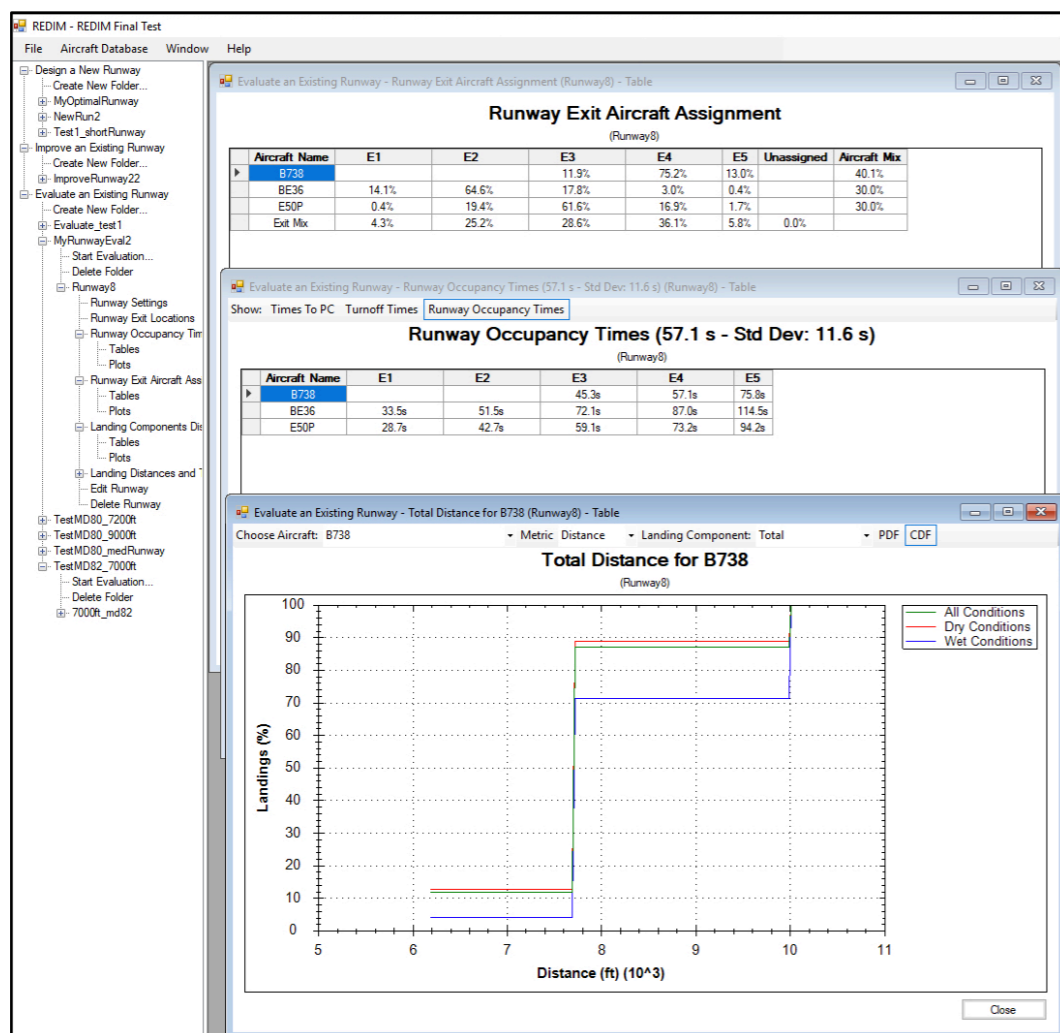
- Uses **six years of data** to calibrate individual aircraft landing roll behavior
- Deceleration rate and touchdown distances are estimated from data but **monotonic with runway length** to reduce **bias** observed in some runway clusters
- Improvements to runway exit logic and runway exit definition (runway exit libraries)





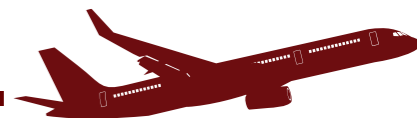
# General Information About the Model

- Model has three analysis modules:
  - a) Evaluation of an existing runway**
  - b) Improvements to an existing runway**
  - c) Design optimal locations for a new runway**



Model uses Monte Carlo Simulation to predict aircraft landing roll performance

- Stand-alone Windows application
- Requires ~1.8 Gb of hard disk space
- Version 4 improvements will be explained in the slides that follow



# Runway Exit Design Model (a Computer Tool)

## Runway Exit Locations and Geometry



REDIM - PHL27L\_9\_25\_2019

File Aircraft Database Window Help

- Design a New Runway
- Improve an Existing Runway
- Evaluate an Existing Runway
  - Create New Folder...
  - Baseline\_PHL27L
    - Start Evaluation...
    - Delete Folder
    - PHL27L\_HS1\_5100
      - Runway Settings
      - Runway Exit Locations
      - Runway Occupancy Tim
      - Runway Exit Aircraft Ass
      - Landing Components Dis
      - Landing Distances and
      - Edit Runway
      - Delete Runway
    - PHL27L\_HS1\_5200
    - PHL\_27L

Evaluate an Existing Runway - Runway Exit Locations (PHL27L\_HS1\_5100) - Table

Runway Exit Locations  
(PHL27L\_HS1\_5100)

Exit	Exit Status	Exit Type	Location (ft)
U	Open	90°	2,310
S7	Open	30° (with 1,500 ft circular arc)	3,350
S6	Closed	90°	3,360
Y	Open	90°	4,400
S8	Open	User Defined	4,865
NewHS1	Open	30° (with 1,800 ft circular arc)	5,098
S9	Closed	90°	5,719
S11	Open	30° (with 1,800 ft circular arc)	6,073
Z	Open	90°	7,136
S12	Open	90°	9,409
S13	Open	90°	9,908

REDIM - PHL27L\_9\_25\_2019 - [Evaluate an Existing Runway - Settings Overview (PHL27L\_HS1\_5100)]

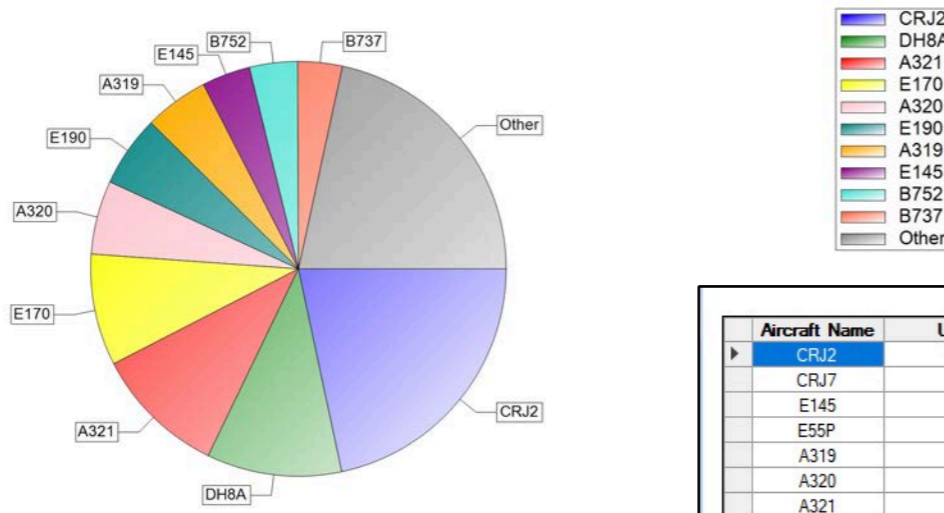
File Aircraft Database Window Help

- Design a New Runway
- Improve an Existing Runway
- Evaluate an Existing Runway
  - Create New Folder...
  - Baseline\_PHL27L
    - Start Evaluation...
    - Delete Folder
    - PHL27L\_HS1\_5100
      - Runway Settings
      - Runway Exit Locations
      - Runway Occupancy Tim
      - Tables
      - Plots
      - Runway Exit Aircraft Ass
      - Landing Components Dis
      - Landing Distances and
      - Edit Runway
      - Delete Runway
    - PHL27L\_HS1\_5200
    - PHL\_27L

Analysis Info

- Selected Aircraft
  - CRJ2 - Bombardier CRJ 200 - 23.5%
  - CRJ7 - Bombardier CRJ 700 - 1.2%
  - E145 - Embraer 145 - 4.1%
  - E55P - Embraer 55 Phenom 300 - 0.6%
  - A319 - Airbus A319 - 5.4%
  - A320 - Airbus A320 - 6.2%
  - A321 - Airbus A321 - 11.2%
  - B737 - Boeing 737-700 - 3.8%
  - B738 - Boeing 737-800 - 3.4%
  - B739 - Boeing 737-900 - 1%
  - CRJ9 - Bombardier CRJ 900 - 1.6%
  - DH8C - DeHavilland Canada Dash-8-300 - 11.4%
  - E170 - Embraer 170 - 9.5%
  - E190 - Embraer 190 - 6%
  - MD88 - McDonnell Douglas MD-88 - 1.5%

Overall Aircraft Mix for PHL



## Aircraft Fleet Mix

## Runway Occupancy Table

(PHL27L\_HS1\_5100)

Aircraft Name	U	S7	S6	Y	S8	NewHS1	S9	S11	Z
CRJ2		31.2s		36.8s	39.6s	41.3s		47.9s	56.9s
CRJ7		33.9s		37.3s	39.9s	41.5s		48.4s	57.6s
E145		33.6s		37.1s	38.9s	40.7s		47.1s	55.6s
E55P		38.2s		45.0s	47.7s	49.2s		56.1s	65.2s
A319		31.0s		38.1s	41.3s	44.3s		51.3s	58.8s
A320				36.7s	40.3s	42.2s		49.0s	56.4s
A321				35.6s	39.2s	40.7s		47.1s	52.8s
B737				36.6s	40.0s	42.0s		49.6s	57.1s
B738								47.3s	53.0s
B739								47.1s	53.5s
CRJ9		28.0s						47.7s	55.9s
DH8C								50.9s	60.3s
E170		32.1s		36.7s	40.2s	42.4s		49.1s	56.1s
E190		32.5s		36.1s	37.6s	42.3s		49.3s	55.6s
MD88				35.6s	40.7s	39.9s		46.0s	53.4s
MD90				35.4s	39.0s	39.7s		45.7s	52.7s
B752		35.2s		41.1s	44.5s	45.8s		52.5s	60.8s
B763				39.0s	43.2s	44.2s		50.8s	57.5s
MD11				36.2s	42.3s	43.0s		49.4s	53.9s
A332				40.8s	46.6s	46.9s		53.6s	58.8s
A333					47.2s	46.1s		53.1s	57.1s
B772					46.4s	45.4s		53.7s	58.8s

Save Table Close



# Runway Exit Design Tool Outputs

Analysis	Purpose	Outputs Produced
<b>Aircraft Mix</b>	Provides an overview of aircraft fleet mix	Percent of aircraft types simulated in the analysis
<b>Runway Occupancy Time</b>	Provides three values of runway occupancy time measured at two locations: 1. Fuselage out 2. At hold bar	1. Average ROT (in seconds) by runway exit and aircraft (table format) 2. Average ROT (in seconds) by runway exit and aircraft (graphical format) 3. Weighted average ROT for the complete aircraft mix using the runway 4. Standard deviation of ROT for the complete fleet mix 5. Individual landing roll times for every aircraft simulated by the model (~50,000 landings per aircraft)
<b>Runway Exit Utilization</b>	Provides information about aircraft assigned to each exit	1. Percent of individual aircraft assigned to each runway exit 2. Individual ROT by aircraft and runway exit
<b>Aircraft Landing Performance</b>	Provides individual landing event information (REDIM uses a Monte Carlo Simulation Process)	1. Landing roll distributions (CDF and PDF) by runway condition (wet or dry) in table format 2. Landing roll distributions (CDF and PDF) by runway condition (wet or dry) in graphical form 3. Landing roll distances and times by aircraft and runway pavement condition (wet or dry) a) Air distance and air time (time to nose gear touchdown) b) Nominal braking distance and time c) Extra roll distance and time d) Turnoff distance and time



# REDIM 3 and 4 Aircraft Database

- REDIM 4.0 contains data for 320 aircraft
  - 150 turbofan aircraft
  - 110 piston aircraft
  - 60 turboprop aircraft

Aircraft Design Group (ADG):  ▼

ADG III Aircraft						
Aircraft ID	Aircraft Name	Engine Type	Aircraft Design Group	Aircraft Approach Category	Nose Gear to Main Gear (m)	
A19N	Airbus A319 Neo	Jet	III	C	11.04	
A20N	Airbus A320 Neo	Jet	III	C	12.64	
A21N	Airbus A321 Neo	Jet	III	C	16.9	
A318	Airbus A318	Jet	III	C	11.04	
A319	Airbus A319	Jet	III	C	11.04	
A320	Airbus A320	Jet	III	C	12.64	
B37M	Boeing 737 MAX 7	Jet	III	C	13.36	
B38M	Boeing 737 MAX 8	Jet	III	D	15.6	
B39M	Boeing 737 MAX 9	Jet	III	D	17.17	
B712	Boeing 717-200	Jet	III	C	17.6	
B717	Boeing 717-200	Jet	III	C	17.6	
B77W	Boeing 777-300ER	Jet	V	D	31.22	67.97
B788	Boeing 787-8	Jet	V	D	22.78	51.31
B789	Boeing 787-9	Jet	V	D	25.83	57.4





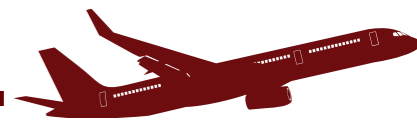
# REDIM 3 and 4 Menu Structure

The screenshot displays the REDIM 3 and 4 menu structure across several windows. The main window shows a project tree with options like 'Design a New Runway', 'Improve an Existing Runway', and 'Evaluate an Existing Runway'. A sub-window titled 'Evaluate an Existing Runway - Runway Occupancy Times (56.4 s - Std Dev: 10.1 s)' is open, showing a table of aircraft names and their occupancy times across five exit points (E1-E5).

**Runway Occupancy Times (56.4 s - Std Dev: 10.1 s)**  
(Runway13\_myAirport)

Aircraft Name	E1	E2	E3	E4	E5
A321		43.2s	53.2s	59.2s	68.4s
A333		51.7s	61.2s	65.0s	71.3s
B738		43.2s	52.6s	58.9s	67.1s
B748		47.3s	58.2s	66.9s	75.3s
B773		45.6s	54.2s	63.1s	70.8s
BE30	28.9s	56.6s	62.2s	74.8s	
BE58	31.0s	60.6s	62.6s		
C206	37.0s	78.9s	89.6s		
C510	29.4s	59.7s	66.1s	73.6s	85.1s
C56X		52.8s	60.2s	68.4s	
CL60		50.4s	57.1s	66.1s	75.1s
CRJ7		44.7s	53.8s	61.9s	72.1s
E145		45.0s	52.8s	61.7s	68.5s
LJ60		48.7s	54.5s	61.7s	
SR22	33.5s	73.5s	77.8s	90.9s	

Buttons: Save Table, Close



# Sample Screens of Runway Exit Design Tool

**Runway Exit Aircraft Assignment**  
(Runway8)

Aircraft Name	E1	E2	E3	E4	E5	Unassigned	Aircraft Mix
B738			11.9%	75.2%	13.0%		40.1%
BE36	14.1%	64.6%	17.8%	3.0%	0.4%		30.0%
E50P	0.4%	19.4%	61.6%	16.9%	1.7%		30.0%
Exit Mix	4.3%	25.2%	28.6%	36.1%	5.8%	0.0%	

**Runway Exit Locations**  
(Runway8)

Exit	Exit Status	Exit Type	Location (ft)
E1	Open	90°	2,500
E2	Open	90°	3,999
E3	Open	30° (with 1,500 ft circular arc)	5,499
E4	Open	90°	7,500
E5	Open	90°	9,800

**Runway Occupancy Times (57.1 s - Std Dev: 11.6 s)**  
(Runway8)

Aircraft Name	E1	E2	E3	E4	E5
B738			45.3s	57.1s	75.8s
BE36	33.5s	51.5s	72.1s	87.0s	114.5s
E50P	28.7s	42.7s	59.1s	73.2s	94.2s

**Total Distance for B738**  
(Runway8)

**Runway Occupancy Times (57.1 s - Std Dev: 11.6 s)**  
(Runway8)

Exit	BE36 (s)	E50P (s)	B738 (s)
E1	33.5	28.7	
E2	51.5	42.7	
E3	72.1	59.1	45.3
E4	87.0	73.2	
E5	114.5	94.2	75.8



# Interface and Panels in the Runway Exit Design Model

The screenshot displays the REDIM - FAA AC Runs software interface. On the left is a navigation and project panel with a tree view containing folders like 'Design a New Runway', 'Evaluate an Existing Runway', and 'AAC A Runs'. The main window shows two panels: a table and a bar chart, both titled 'Runway Occupancy Times (33.7 s - Std Dev: 4.4 s)'. The table lists aircraft names and their occupancy times across seven exit points (e1-e7). The bar chart visualizes these times, with a legend on the right identifying aircraft by color.

Aircraft Name	e1	e2	e3	e4	e5	e6	e7
BE33		21.8s	24.7s	27.4s	30.3s	33.2s	36.0s
BE35		21.4s	24.6s	27.7s	30.6s	33.3s	36.2s
BE36		21.2s	24.1s	26.6s	29.7s	32.5s	35.6s
C152			25.3s	28.6s	31.7s	34.7s	38.1s
C172			25.4s	28.5s	31.7s		
C177		21.2s	24.6s	27.5s	30.8s		
C182		21.2s	24.3s	27.5s	30.5s		
C206	17.5s	21.0s	24.5s	27.1s	30.3s		
C208	18.6s	21.7s	24.6s	27.4s	30.1s		
C210	18.0s	20.4s	24.4s	27.0s	30.1s		
COL4		20.1s	24.6s	26.6s	29.5s		
DA40		21.6s	23.8s	27.1s	30.3s	33.4s	36.7s
M20P	18.1s	21.2s	23.7s	26.7s	29.6s	32.5s	35.8s
P28A	18.4s	21.5s	24.4s	27.6s	30.5s	33.6s	36.9s
P32R	18.0s	21.0s	23.9s	26.4s	29.0s	31.9s	34.2s

Tables with relevant model results

Navigation and project panel with information and results

Plots of relevant model results



# Navigation/Project Panel Hierarchy

Design a new runway

Improve an existing runway

Evaluate an existing runway

Project folder

Scenarios inside project folder

Scenario settings

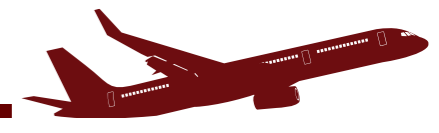
Runway exit locations

Runway occupancy times (tables and plots)

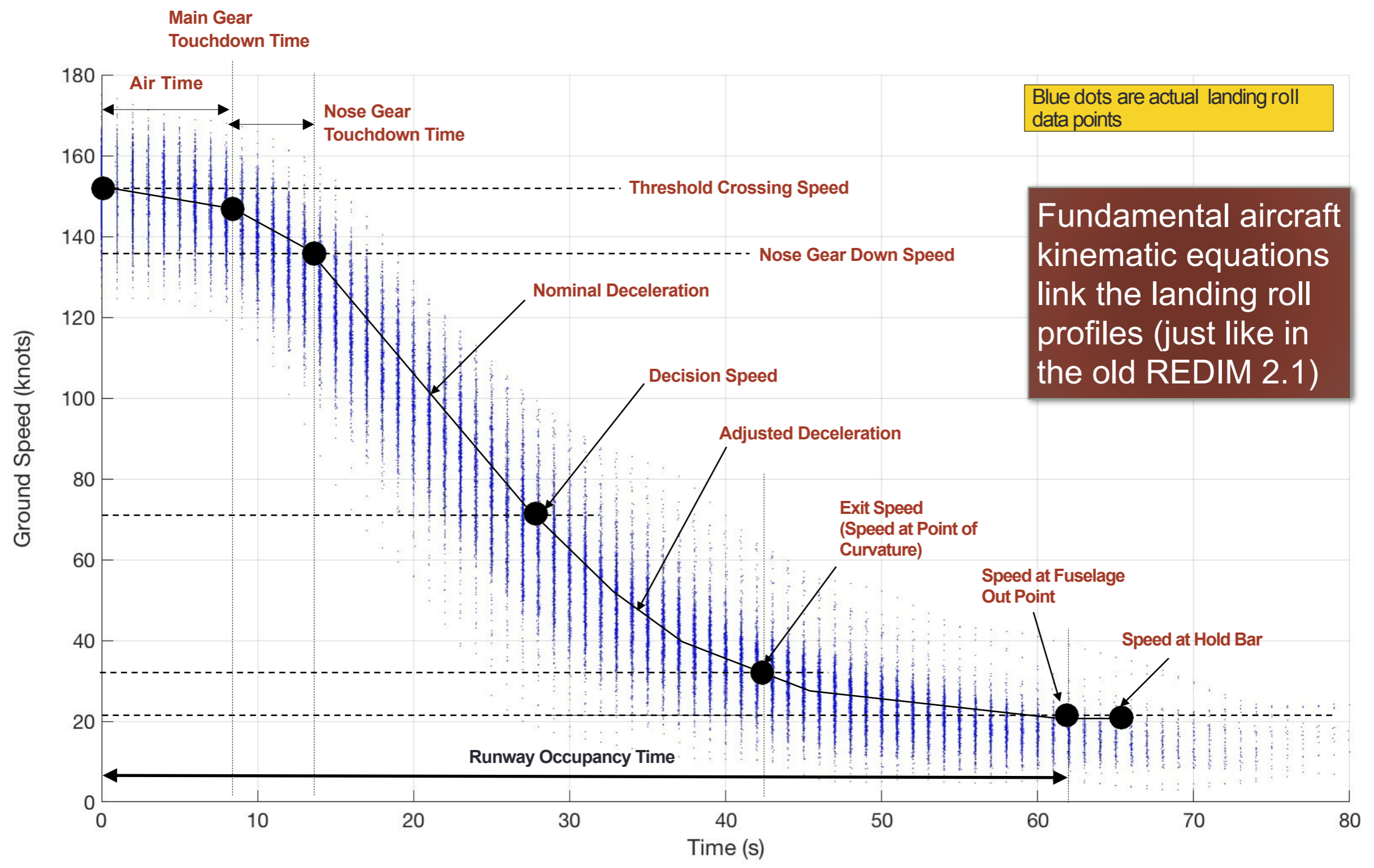
Runway exit assignment (tables and plots)

Aircraft landing distributions (tables and plots)

Aircraft landing distances and times (tables and plots)



# Runway Exit Model Landing Roll Profile Phases Modeled

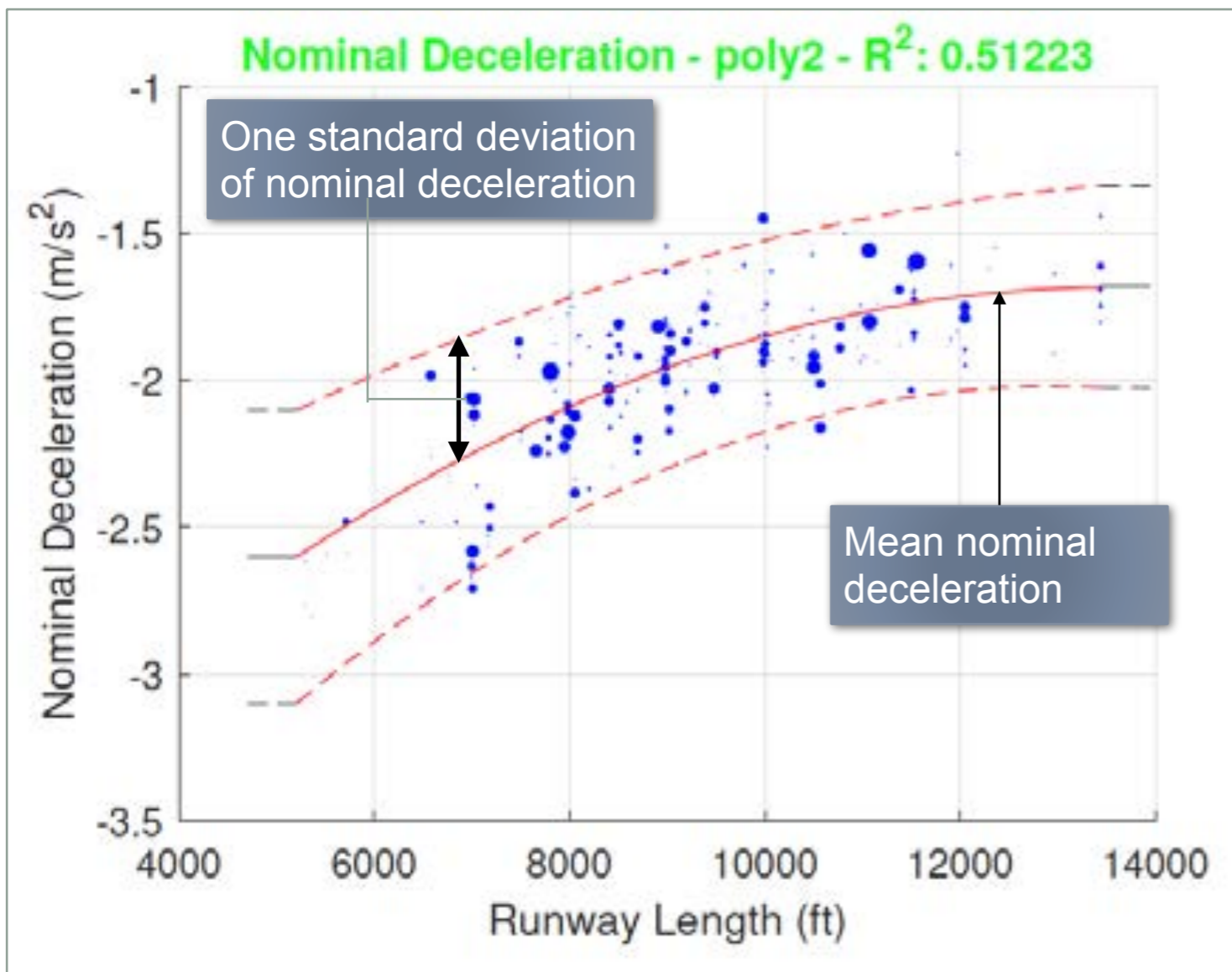




# REDIM 4 Individual Aircraft Deceleration Model



## Airbus A320 Data



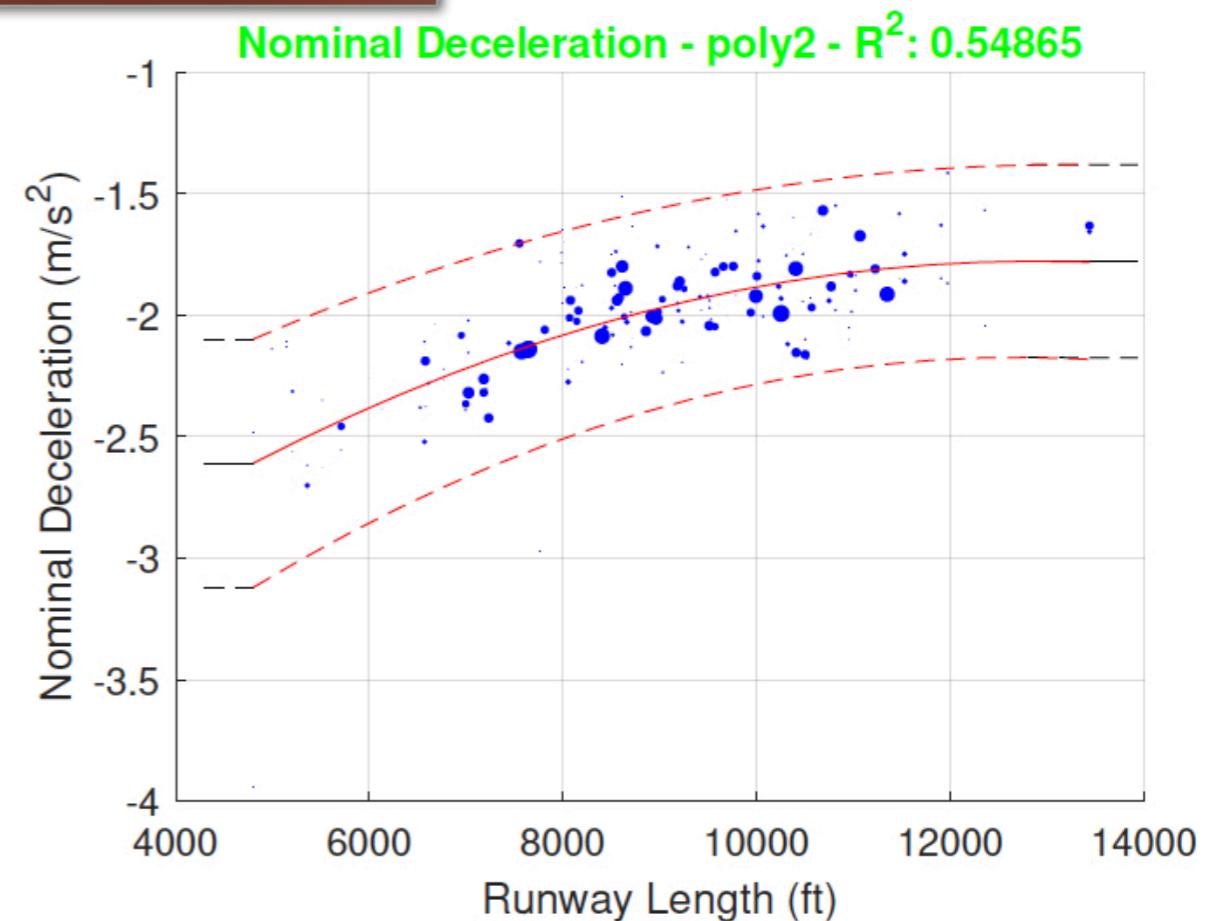
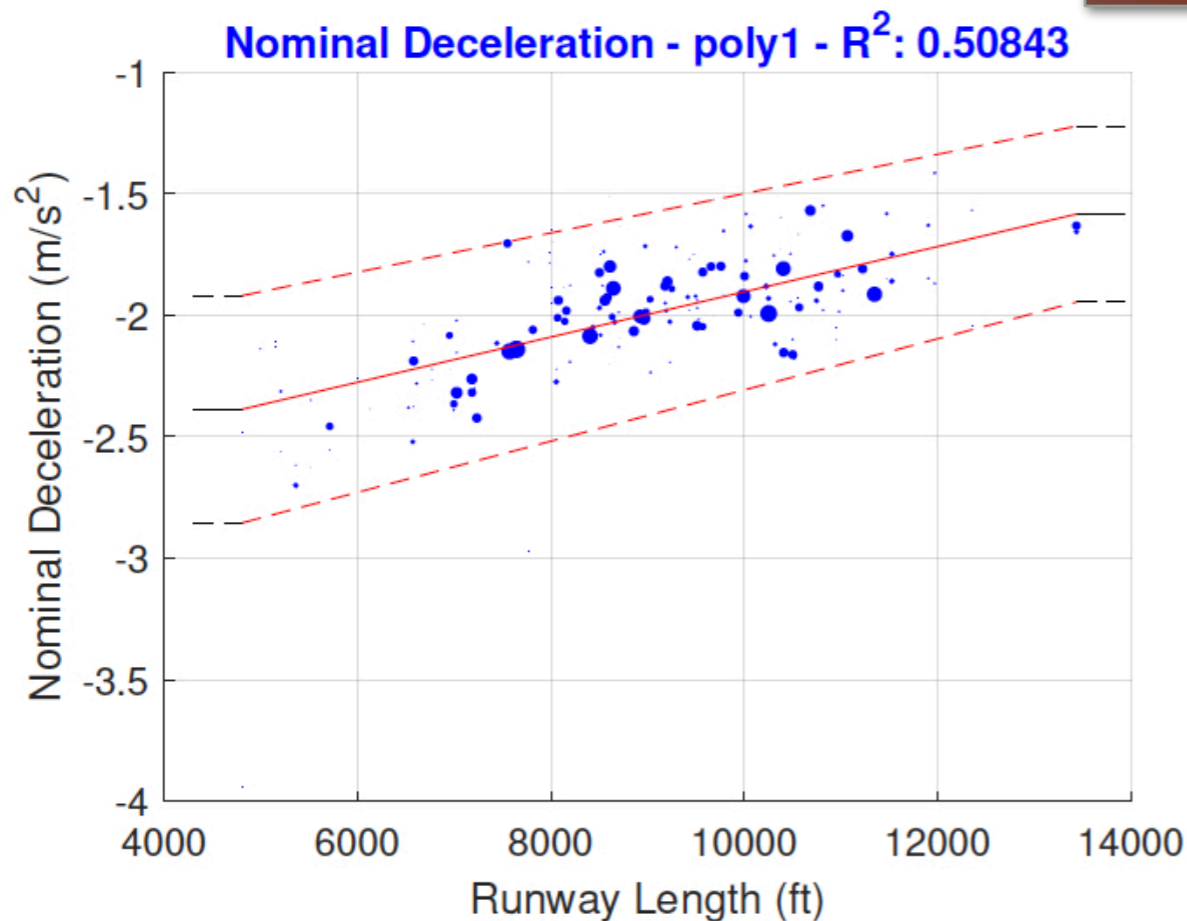
- Model selects the best polynomial fit of nominal deceleration as a function of runway length
- Deceleration data is monotonic
- Each dot is a runway end of data collected at 43 airports
- Each dot is weighted by the number of operations at every airport



# Runway Landing Behavior Changes: Nominal Deceleration Rate Model

- Developed statistical models (using linear and second order polynomials) to relate nominal deceleration rate and runway length
- Derived models for 300+ aircraft and also for AAC groups (used as defaults when the number of landing events is not sufficient to create a statistically valid model)

## AAC Group C Model

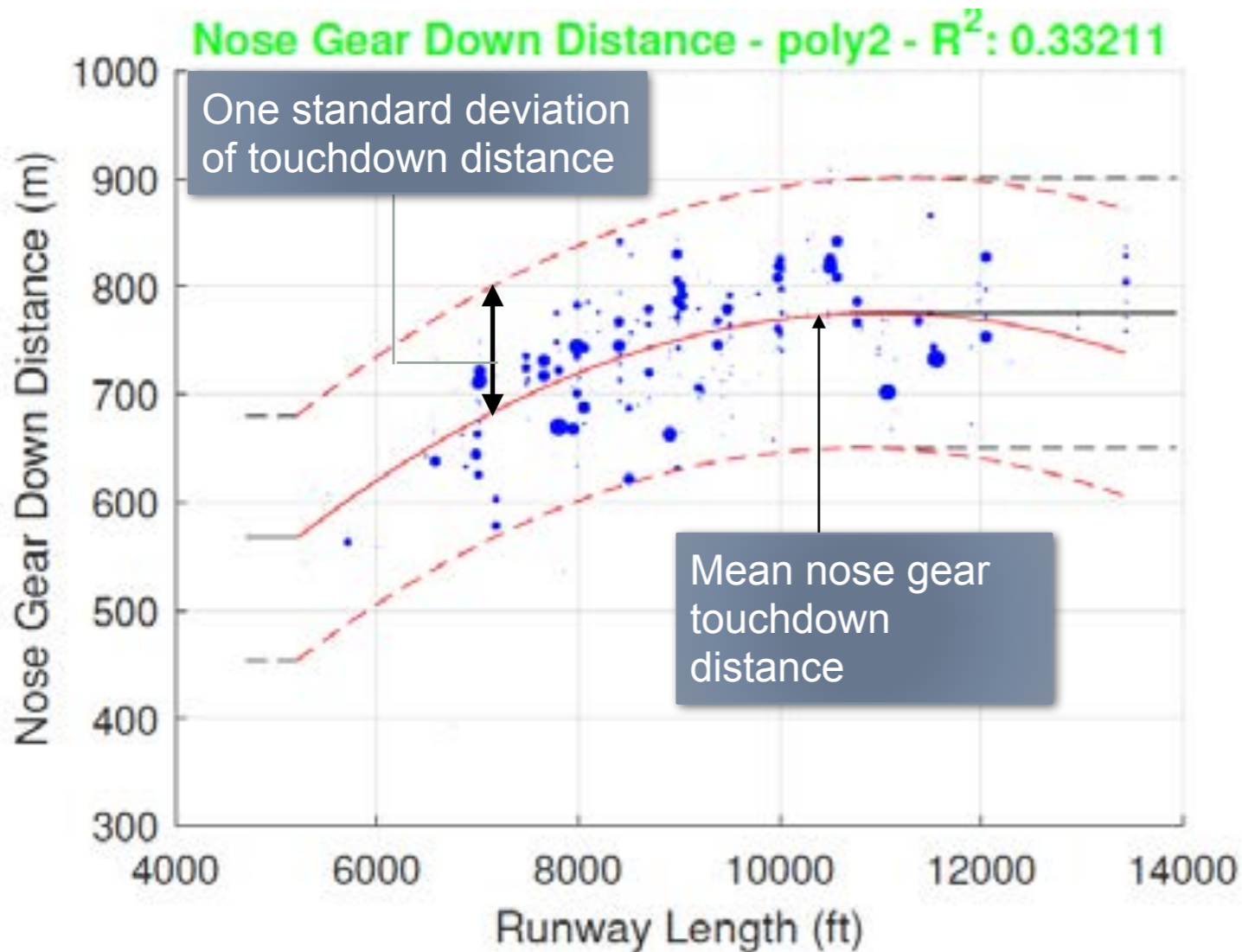




# REDIM 4 Individual Aircraft Touchdown Model



Airbus A320 Data



- Model selects the best polynomial fit of the touchdown location as a function of runway length
- Touchdown data is monotonic
- Each dot is a runway end of data collected at 43 airports
- Each dot is weighted by the number of operations at every airport

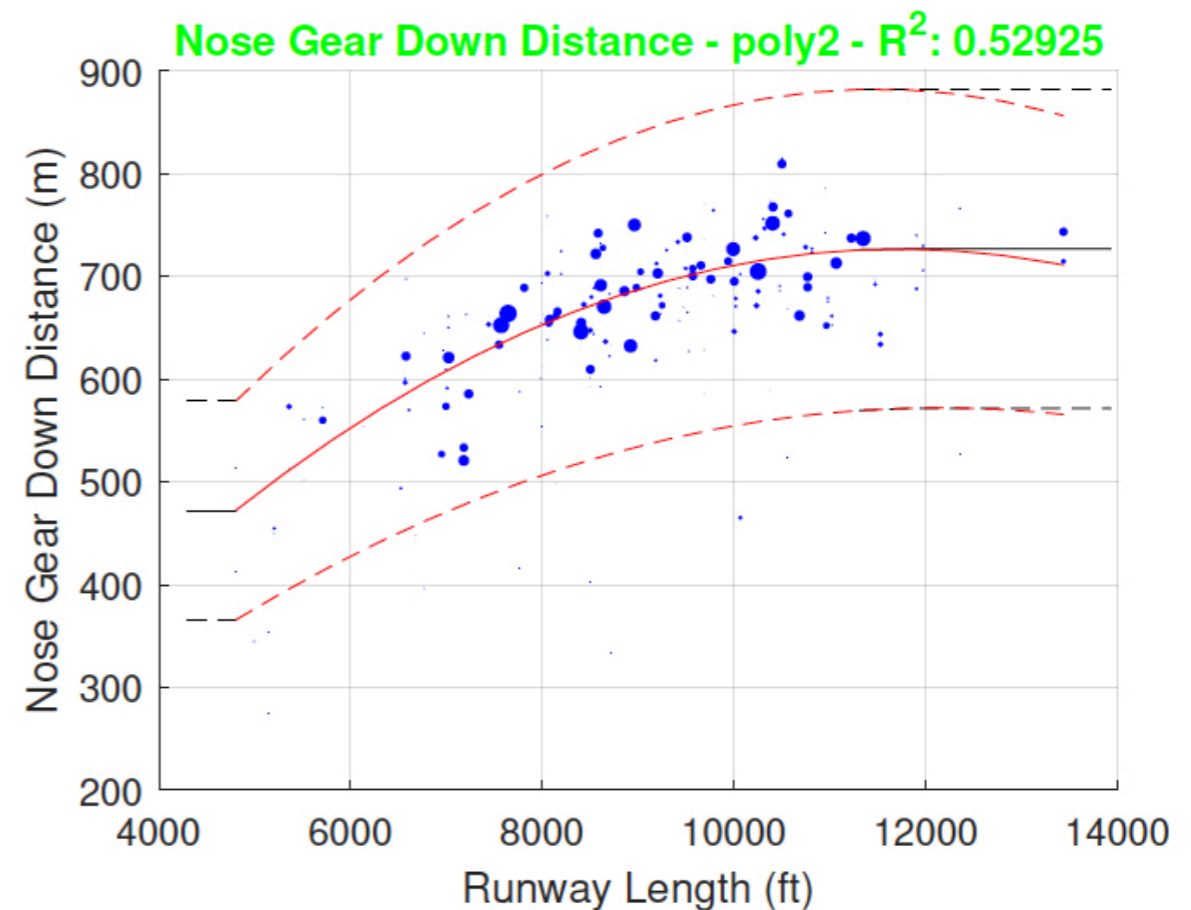
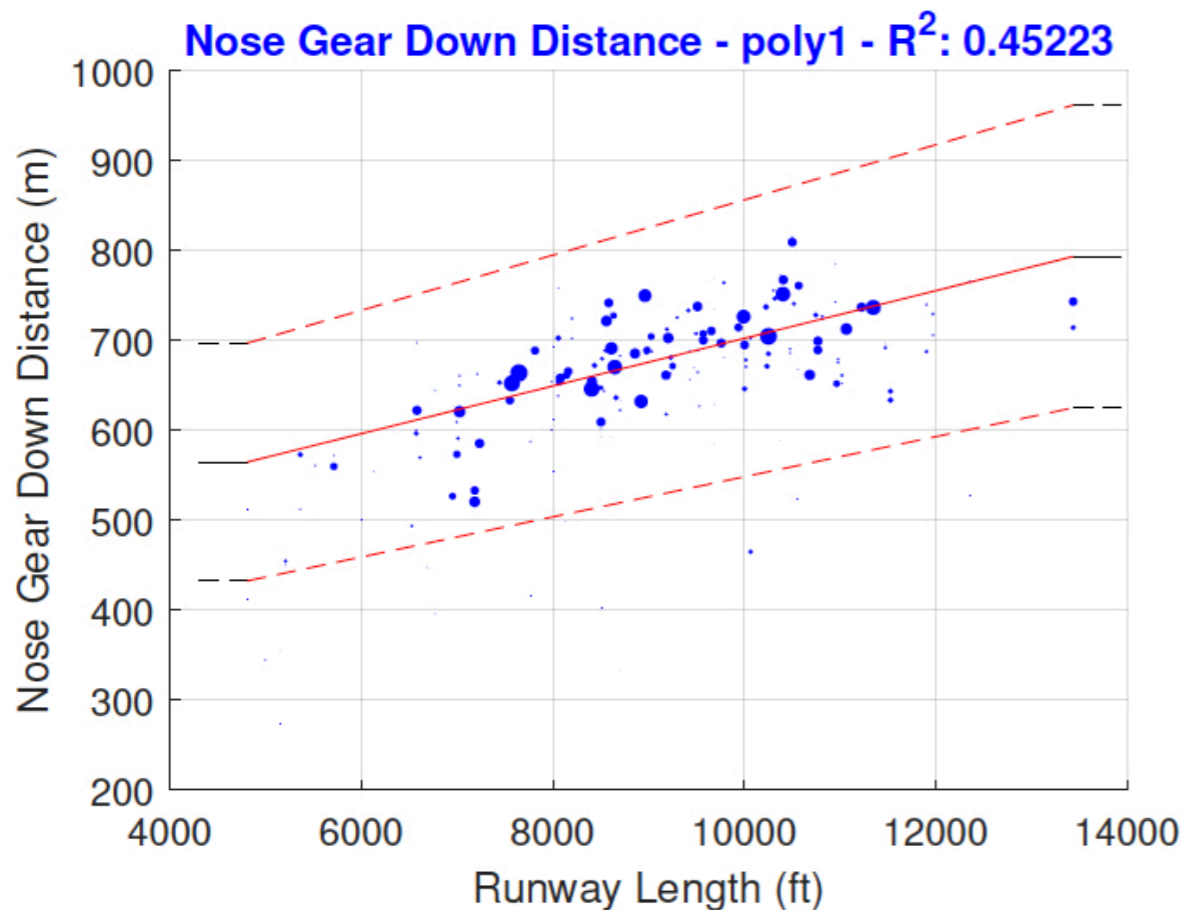




# Runway Landing Behavior Changes: Touchdown Location Model (AAC Group Model)

- Developed statistical models (using linear and second order polynomials) to relate touchdown location (nose gear) and runway length
- Standard deviation metrics are also available in the analysis

## AAC C - All - Mean & +/- 1 StdDev - Weighted

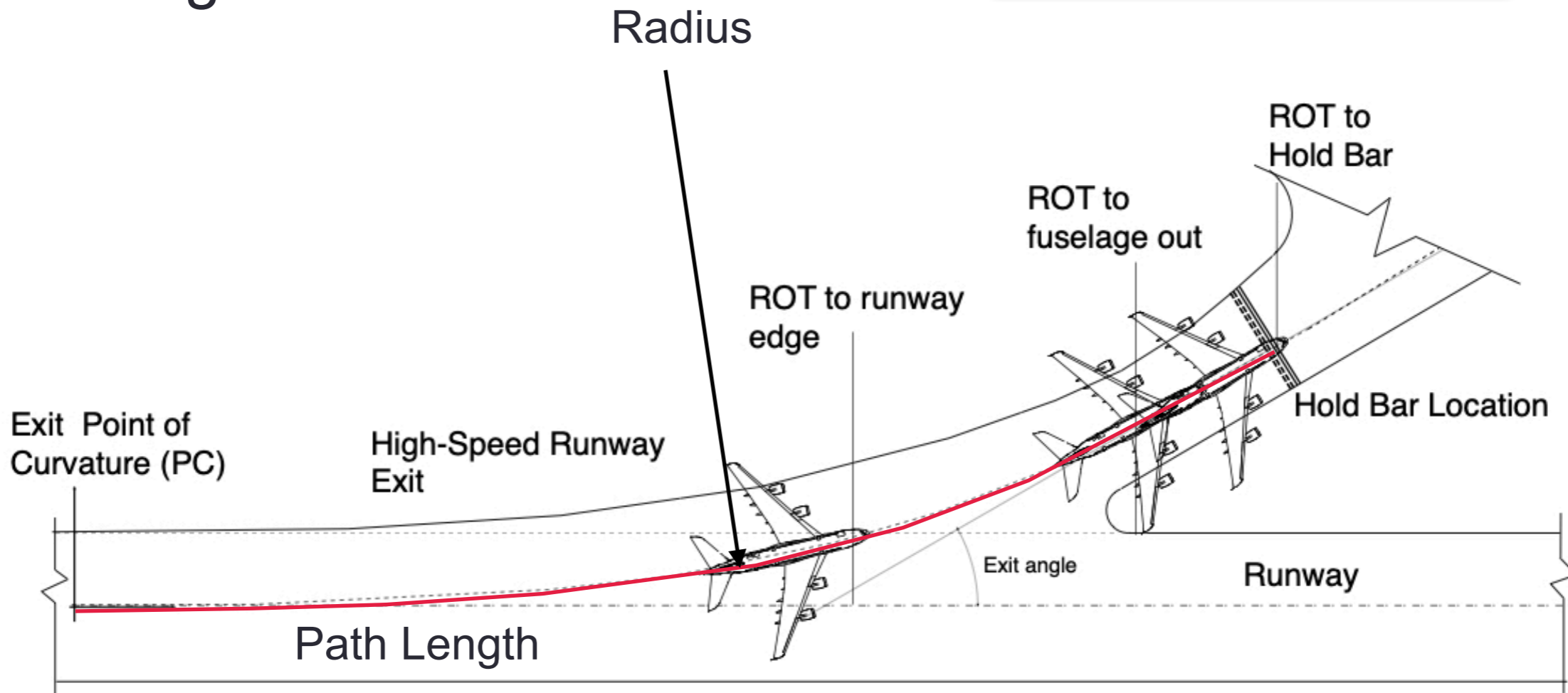




# Runway Exit Clusters and Geometry

- Three parameters define the **runway exit cluster**:
  - Radius
  - Path length to hold bar
  - Exit angle

Each runway exit cluster has a distinct aircraft speed behavior

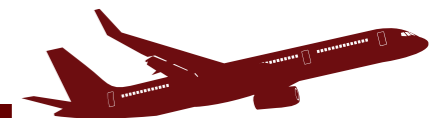




# Runway Exit Clusters in REDIM 3 and 4

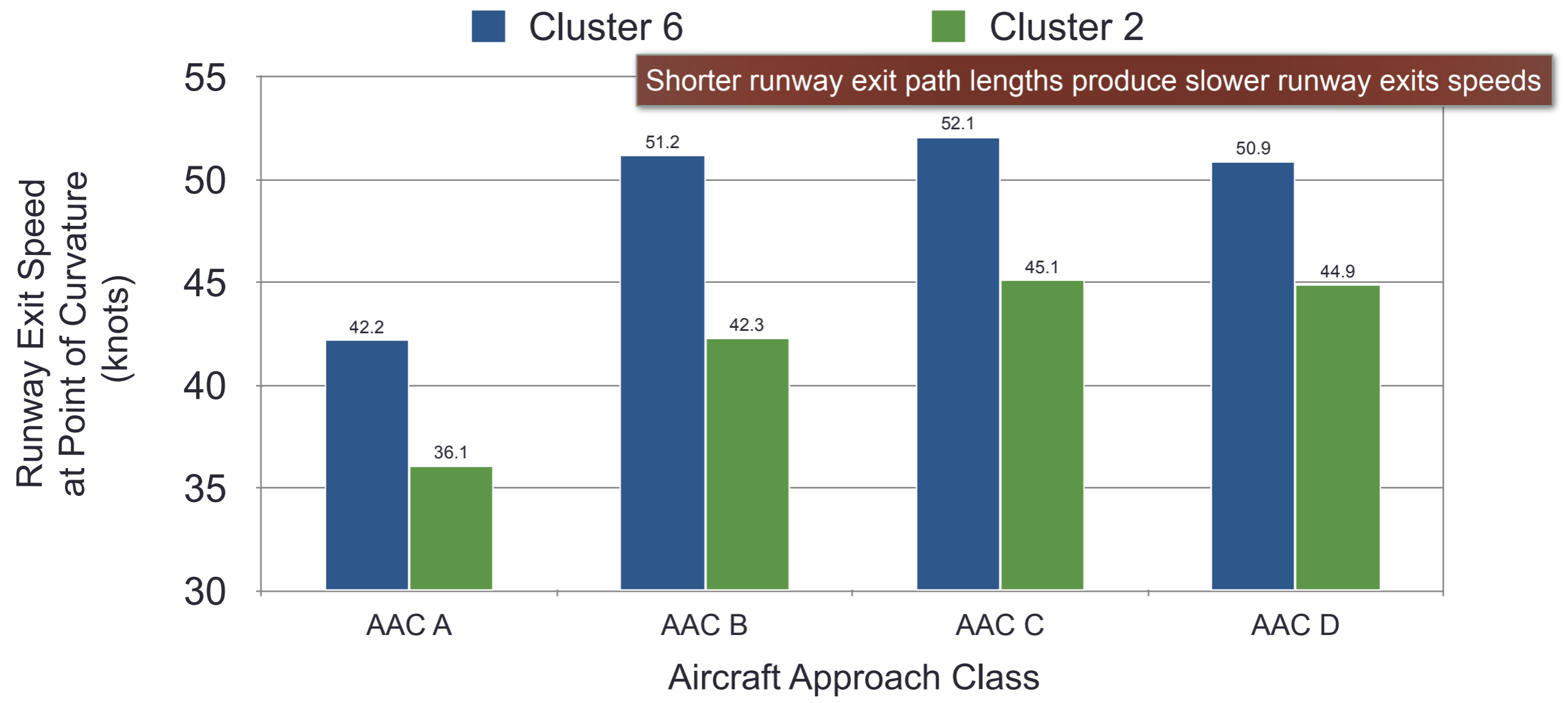
Cluster #	Angle (deg)		Radius (ft)		Path Length (ft)		Number Of Exits	Type of Runway Exit
	Min	Max	Min	Max	Min	Max		
7	50	76	150	590	426	696	55	Intermediate angle, midsize path length
4	25	53	150	600	494	708	59	Acute angle, modest radius, midsize path length
16	30	70	400	900	966	1158	58	Intermediate angle, long path length
17	21	61	300	900	715	956	28	Acute angle, midsize radius, long path length
5	23	53	500	1000	1130	1546	13	Acute angle, midsize radius, long path length
13	28	65	675	1400	584	872	66	Acute angle, long radius, midsize path length
12	30	52	1200	1503	761	1108	37	Acute angle, midsize radius, long path length
2	30	57	1800	1800	677	1043	96	Acute angle, long radius, midsize path length
6	20	30	1400	1800	1233	1684	63	Acute angle, long radius, long path length
18	20	35	1800	1800	1047	1224	95	Acute angle, long radius, long path length

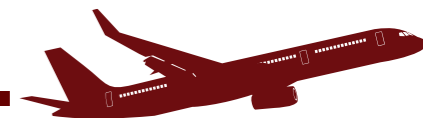
Model uses 20 runway exit clusters to differentiate runway exit characteristics



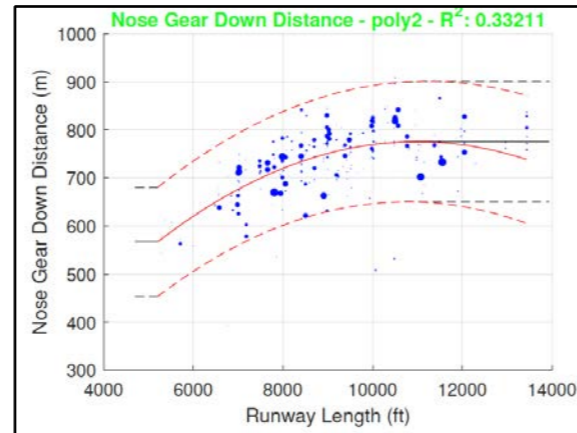
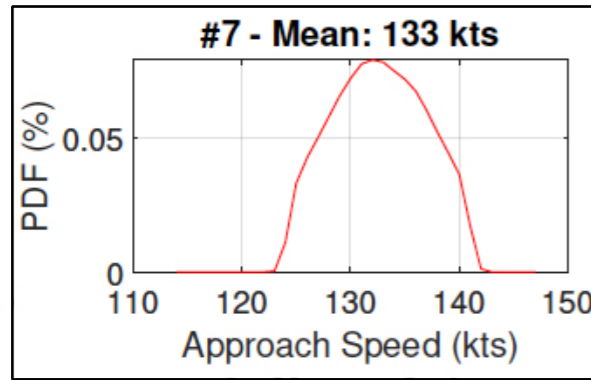
# Effect of Runway Exit Cluster on Exit Speed

Cluster #	Angle (deg)		Radius (ft)		Path Length (ft)		Number Of Exits	Type of Runway Exit
	Min	Max	Min	Max	Min	Max		
2	30	57	1800	1800	677	1043	96	Acute angle, long radius, midsize path length
6	20	30	1400	1800	1233	1684	63	Acute angle, long radius, long path length

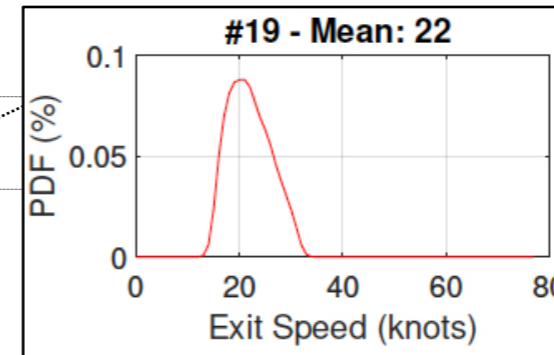
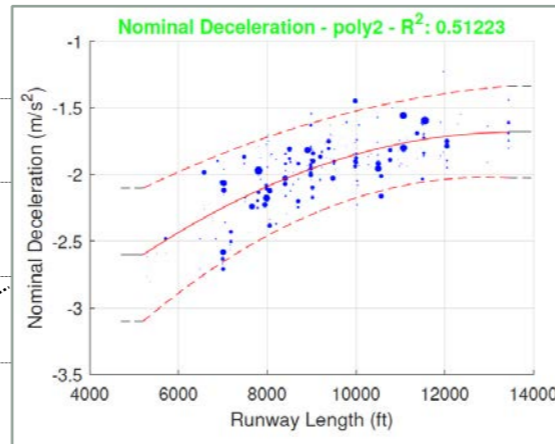
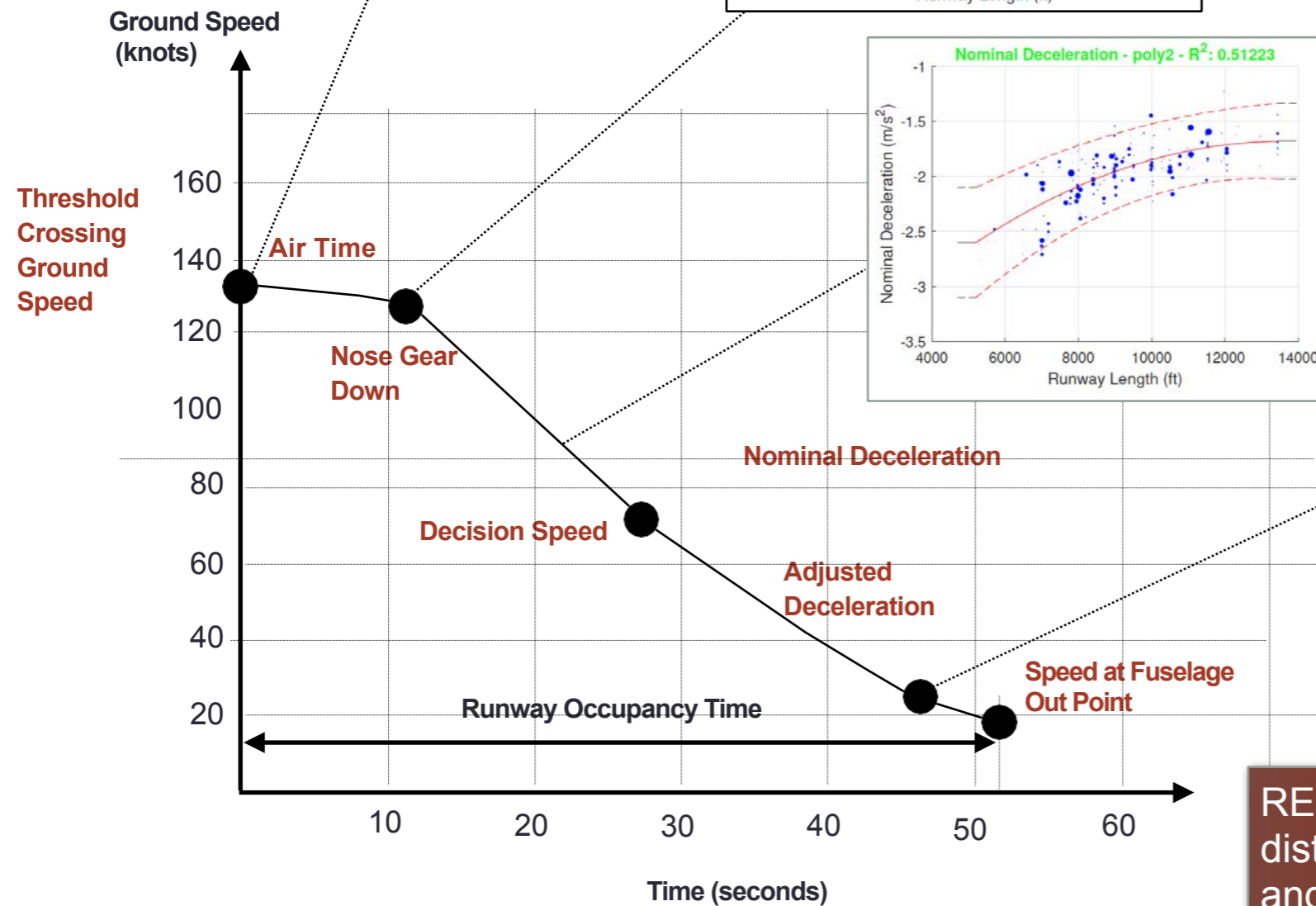




# Monte Carlo Simulation in REDIM 4



Typical distributions for an Airbus A320 landing



Exit Speed Distribution for Cluster 2 runway exit - right angle runway exit

REDIM 4 uses the new polynomial distributions for nominal deceleration rate and touchdown location



# REDIM 3/4 Output (Tabular Form)

Choose Aircraft: A320

Distances Times Speeds & Decelerations

Landing Number	Wet Conditions	Exit	Air Distance (ft)	Braking Distance (ft)	Extra Roll Distance (ft)	Turnoff Distance (ft)	Total Distance (ft)
1		A	2,447	2,154	1,452	258	6,311
2		E-22	2,001	1,963	737	259	4,961
3		E-22	2,000	1,825	877	257	4,958
4		A	2,426	2,596	1,031	260	6,313
5		A	1,846	2,234	1,973	258	6,311
6		Last	2,504	3,216	1,130	258	7,108
7		A	2,366	2,087	1,600	259	6,312
8		A	1,999	2,341	1,713	259	6,312
9		E-22	2,624	1,506	572	259	4,960
10		F_L	2,049	1,655	716	259	4,678
11		A	2,191	2,153	1,709	258	6,311
12		A	2,159	2,010	1,884	259	6,312
13		A	2,247	1,894	1,912	259	6,312
14		E-22	2,054	1,920	727	260	4,961
15	Yes	A	2,232	1,986	1,835	259	6,316
16		A	2,141	2,195	1,717	260	6,313
17		F_L	1,700	1,763	956	258	4,677
18							
19							
20							

All output tables can be exported as Comma Separated Format files

Landing events with a wet runway

Every landing simulated in REDIM 3 is reported in tables

Evaluate an Existing Runway - Landing Speeds & Decelerations for A320 (Runway19) - Table

Choose Aircraft: A320

Distances Times Speeds & Decelerations

### Landing Speeds Decelerations for A320 (Runway19)

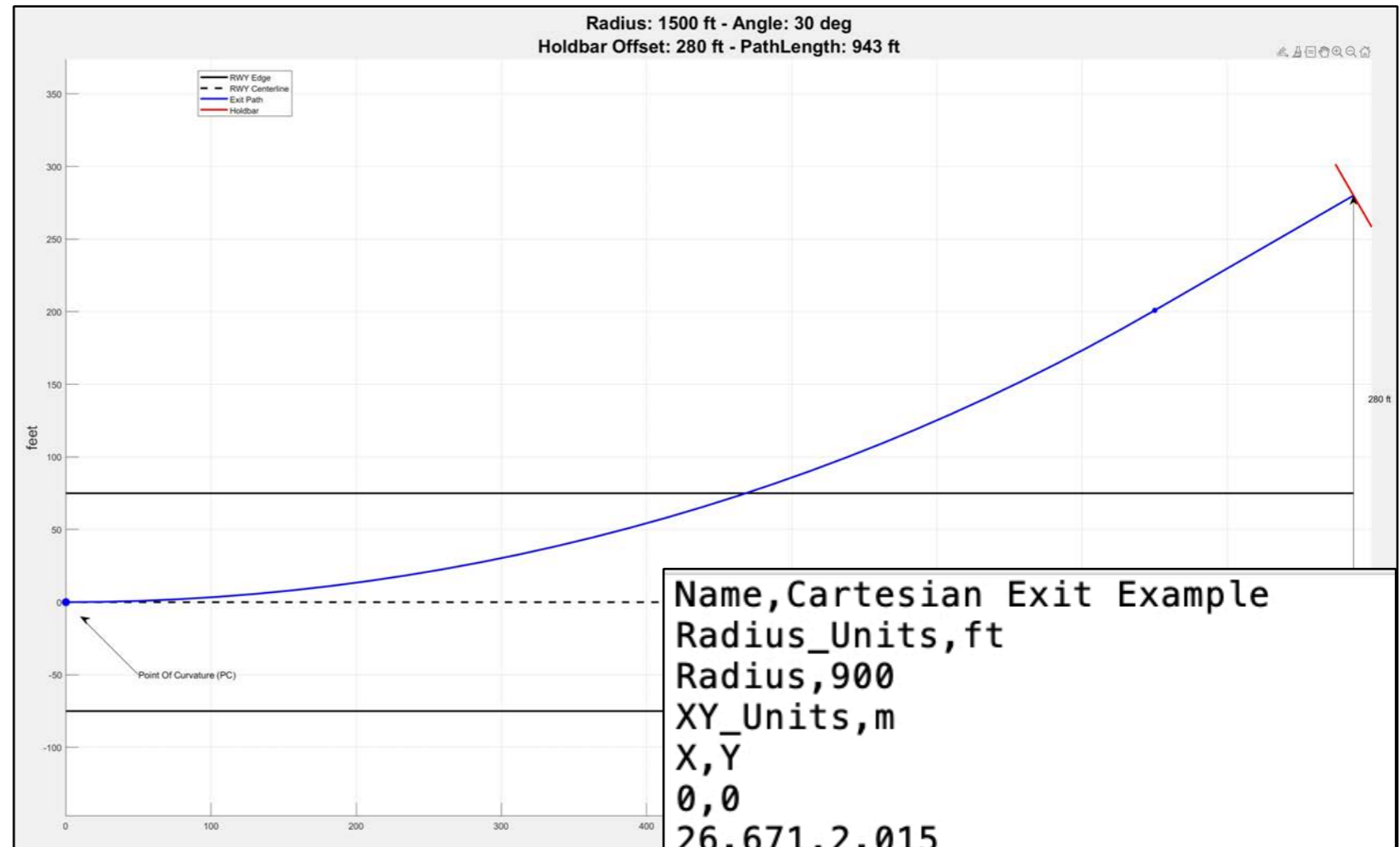
Landing Number	Wet Conditions	Exit	Threshold Crossing Speed (knots)	Touchdown Speed (knots)	Nominal Speed (knots)	Speed at PC (knots)	Nominal Deceleration (m/s <sup>2</sup> )	Deceleration to PC (m/s <sup>2</sup> )	Deceleration after PC (m/s <sup>2</sup> )	Touchdown Speed Coefficient
1		A	132	125	70	16	-2.17	-1.38	-0.34	0.95
2		E-22	132	125	70	22	-2.37	-2.61	-0.34	0.95
3		E-22	129	122	70	23	-2.39	-2.16	-0.34	0.95
4		A	129	122	70	23	-1.69	-1.84	-0.34	0.95
5		A	138	131	70	23	-2.40	-0.96	-0.34	0.95
6		Last	141	134	70	21	-1.77	-1.71	-0.34	0.95
7		A	135	128	70	25	-2.41	-1.17	-0.34	0.95
8		A	130	123	70	24	-1.91	-1.09	-0.34	0.95
9		E-22	127	121	70	28	-2.80	-3.13	-0.34	0.95
10		F_L	131	124	70	22	-2.77	-2.68	-0.34	0.95
11		A	134	127	70	18	-2.29	-1.16	-0.34	0.95
12		A	128	122	70	17	-2.14	-1.06	-0.34	0.95
13		A	126	119	70	20	-2.15	-1.02	-0.34	0.95
14		E-22	140	133	70	24	-2.91	-2.58	-0.34	0.95
15	Yes	A	131	124	70	28	-2.29	-0.97	-0.34	0.95
Average			133	126	70	24	-2.21	-1.62	-0.34	0.95

Save Table Close



# Runway Exit Design Library (REDIM 4)

- Standard exit geometry libraries will be in the model to facilitate the runway exit design assessment process
- For custom runway exits (many airports have exits that do not conform to a standard) a user defines runway exits using simple parameters employing cartesian or absolute latitude and longitude coordinates



Name, Cartesian Exit Example
Radius_Units, ft
Radius, 900
XY_Units, m
X, Y
0, 0
26.671, 2.015
42.047, 3.688
57.997, 5.654
72.971, 8.734
97.812, 15.907
113.304, 21.596
125.011, 26.633
138.622, 33.627
152.282, 41.414
164.893, 49.682
177.397, 59.000
292.216, 161.161



# Runway Exit Design Library and Improved Turnoff Simulation

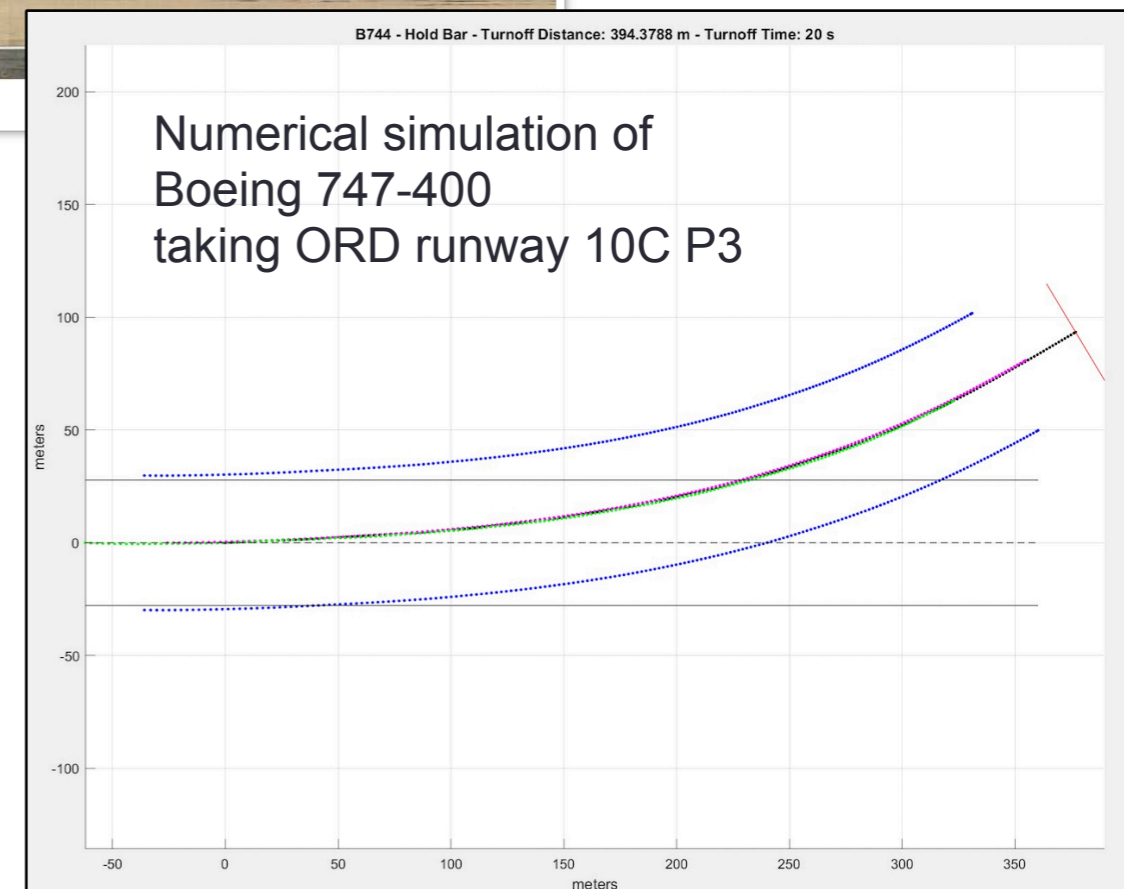
- Purpose is to handle more efficiently how users define runway exits
- A library allows a user to specify either standard or custom exits and just place them along the runway
- Model simulates numerically the path of the aircraft while taking the runway exit

Evaluate an Existing Runway - Step 3 - Exits

**Step 3: Exits**

Name	Point Of Curvature Location (ft)	Geometry	Open
A	2000	90 deg 125 ft	<input checked="" type="checkbox"/>
B	4000	30 deg HighSpeed	<input checked="" type="checkbox"/>
C	6000	30 deg HighSpeed	<input checked="" type="checkbox"/>
D	8000	30 deg HighSpeed	<input checked="" type="checkbox"/>
E	9843	90 deg 200 ft	<input checked="" type="checkbox"/>
*			<input type="checkbox"/>

The diagram shows an aerial view of a runway exit. A blue arrow points to the 'PC (Point Of Curvature)' on the runway. Another blue arrow points to the 'Angle' of the exit. A third blue arrow points to the 'Holdbar Offset' from the runway edge to the exit path.

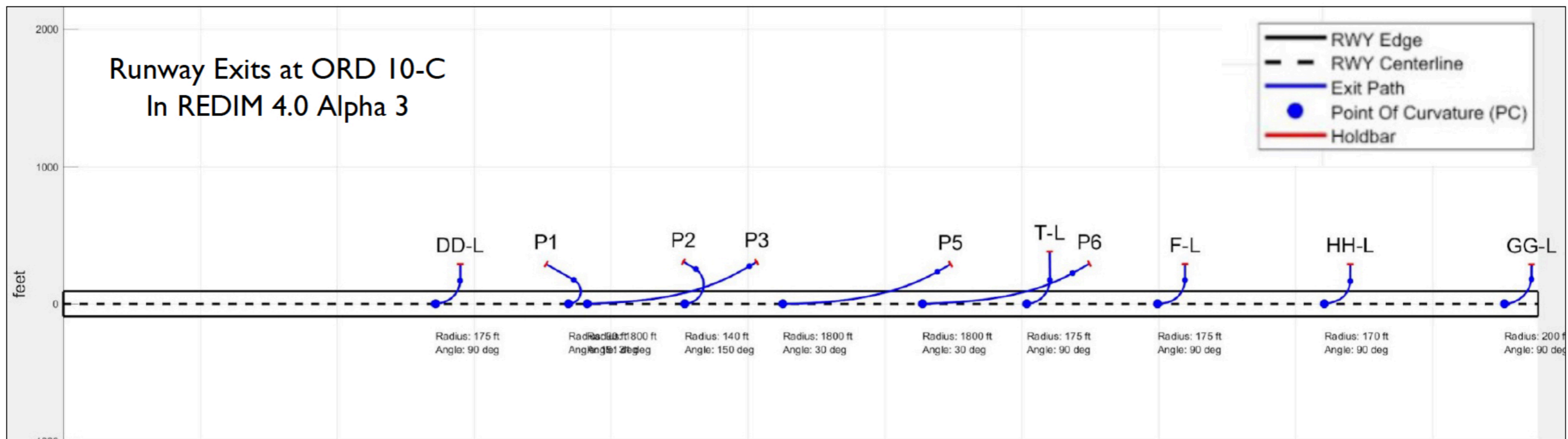






# Runway Exits along the Runway (REDIM 4)

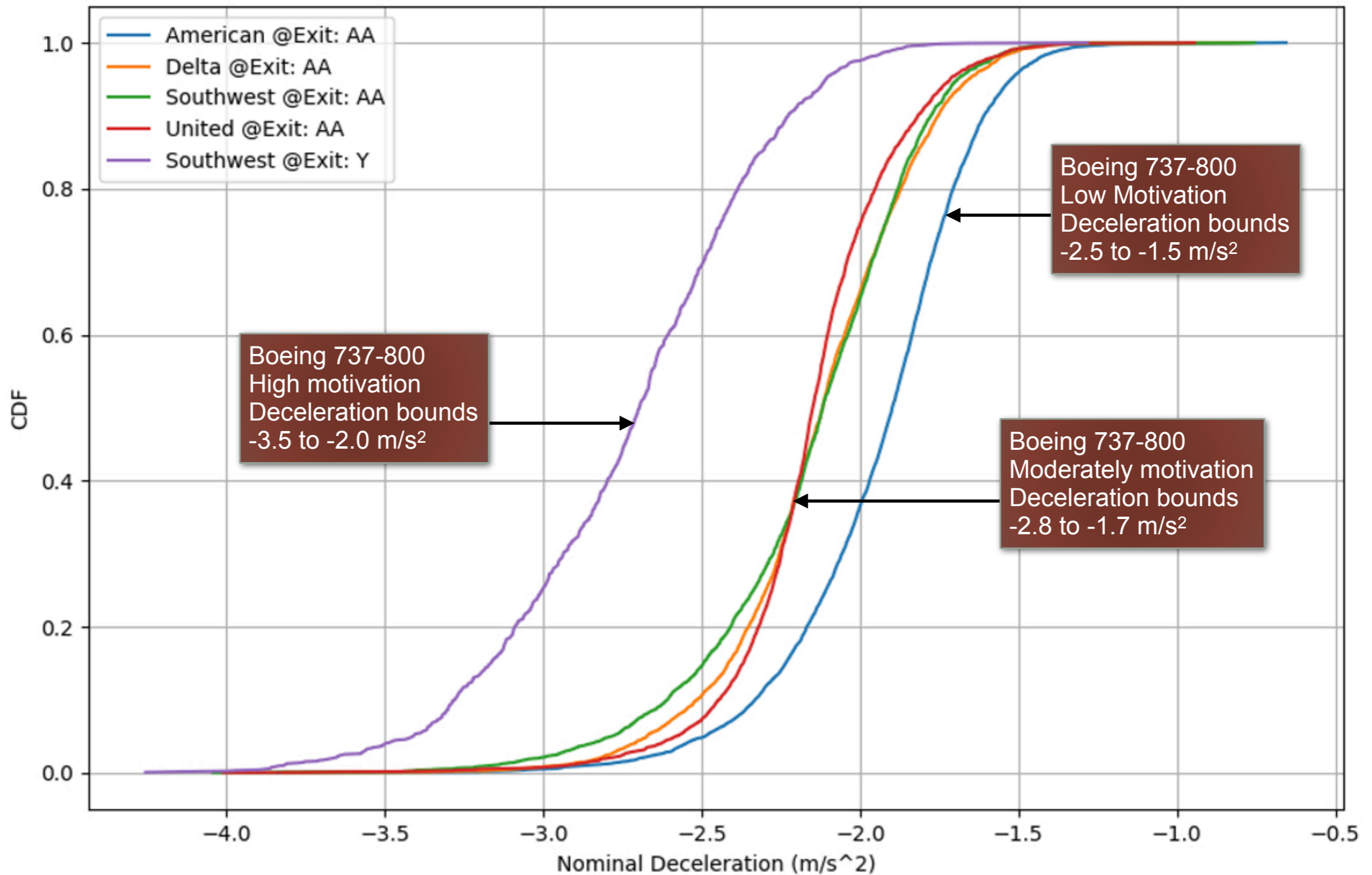
- Purpose is to handle more efficiently how users define runway exits
- A library allows a user to specify either standard or custom exits and just place them along the runway
- Model simulates numerically the path of the aircraft while taking the runway exit



Screen capture of REDIM 4.0



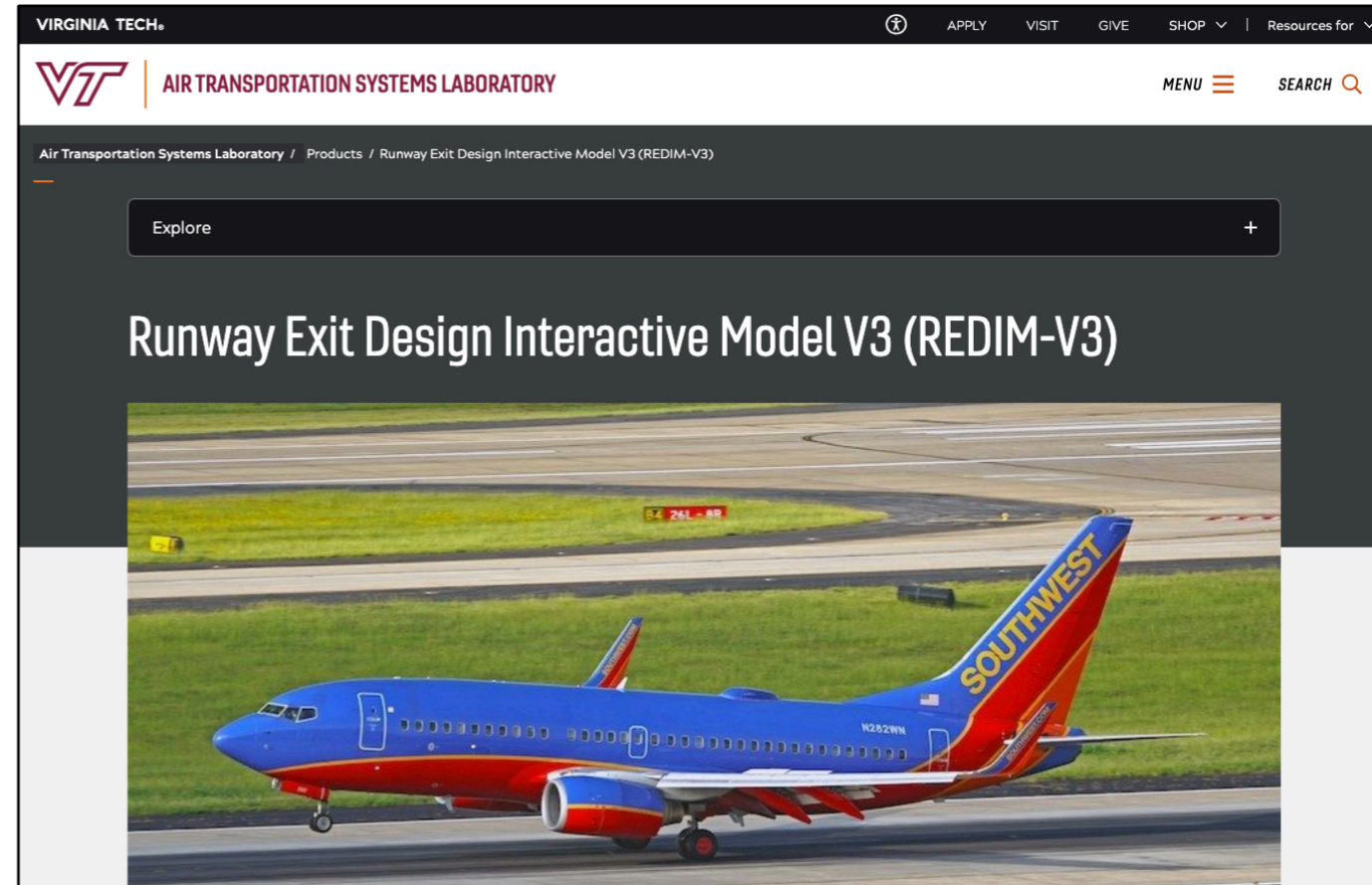
# Pilot Motivational Practice: Los Angeles Airport





# Contact Information and Web Site

- For more information or questions about the tools presented you can contact us:
- Toni Trani ([vuela@vt.edu](mailto:vuela@vt.edu))
- Nick Hinze ([nhinze@vt.edu](mailto:nhinze@vt.edu))



<https://atsl.cee.vt.edu/products/runway-exit-design-interactive-model--redim-.html>