CEE 4674 / CEE 5614
Aviation Databases and Web Information

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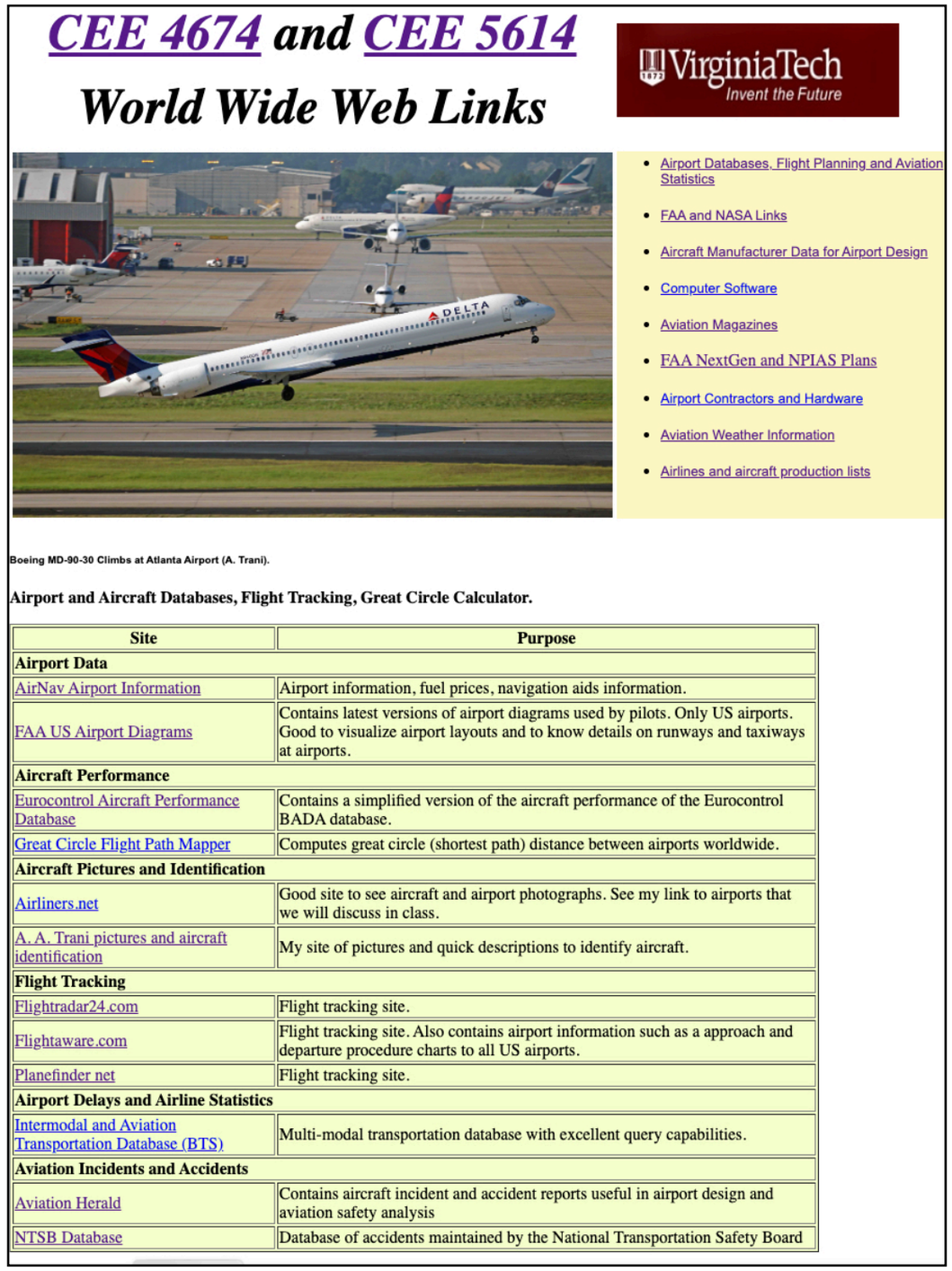
Fall 2023

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



CEE 4674 and CEE 5614

World Wide Web Links

VirginiaTech
Invent the Future

- 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.

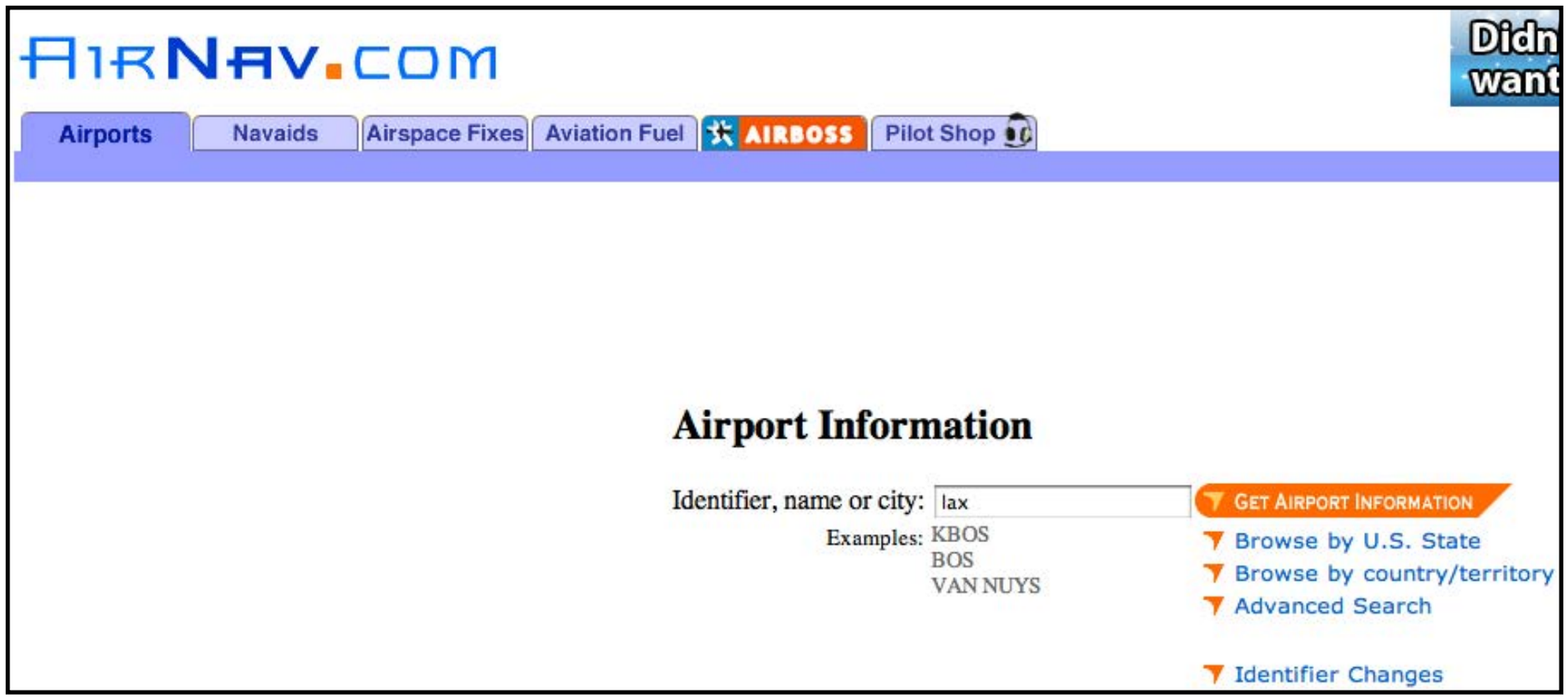
Site	Purpose
Airport Data	
AirNav Airport Information	Airport information, fuel prices, navigation aids information.
FAA US Airport Diagrams	Contains latest versions of airport diagrams used by pilots. Only US airports. Good to visualize airport layouts and to know details on runways and taxiways at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



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

Runway 7L/25R

Runway dimension and pavement surface condition including weight bearing capacity

Runway threshold elevation

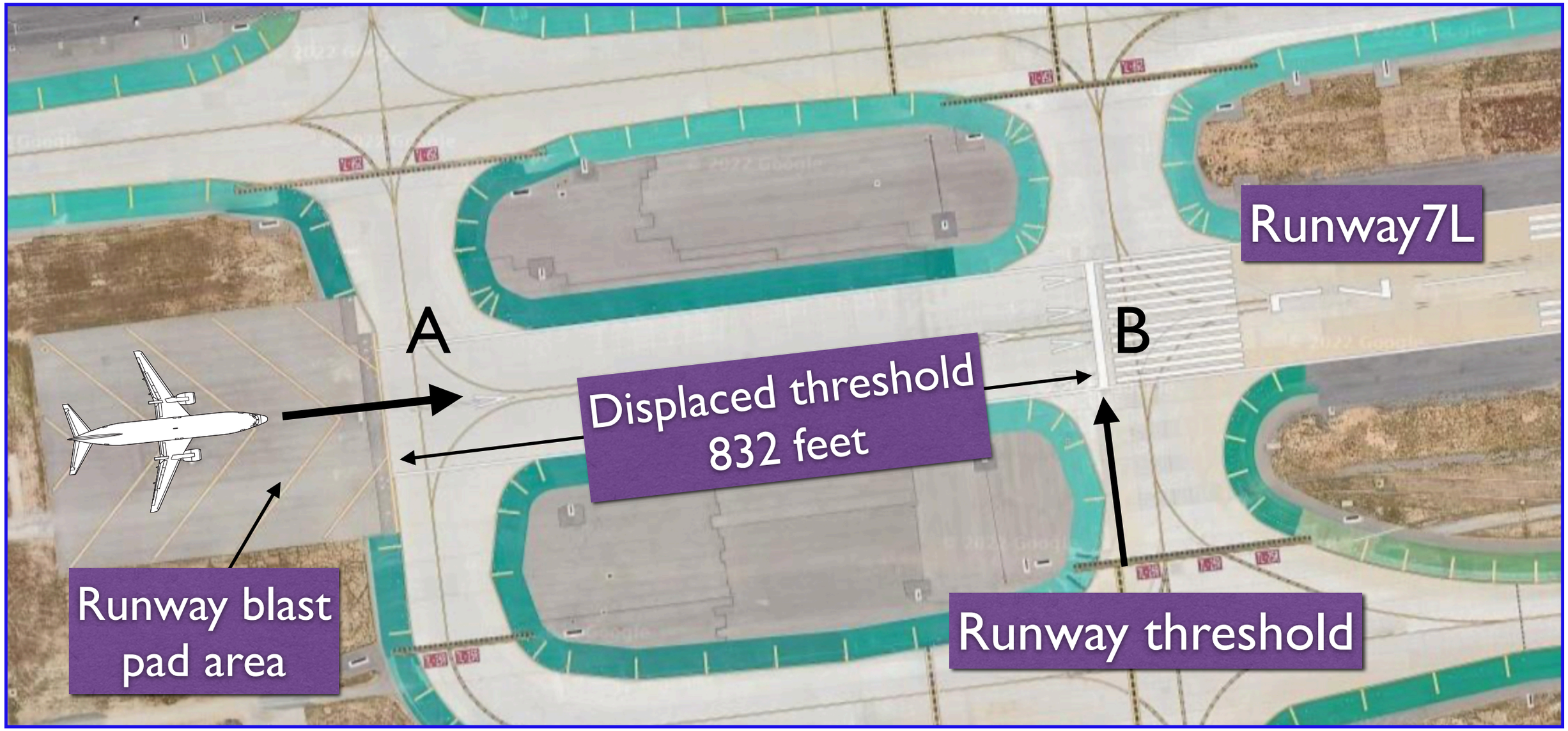
Runway heading, displaced threshold and declared distances

Runway visual slope indicator and runway approach lights

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

Displaced threshold 832 feet

Los Angeles International Airport Runway 7L/25R information



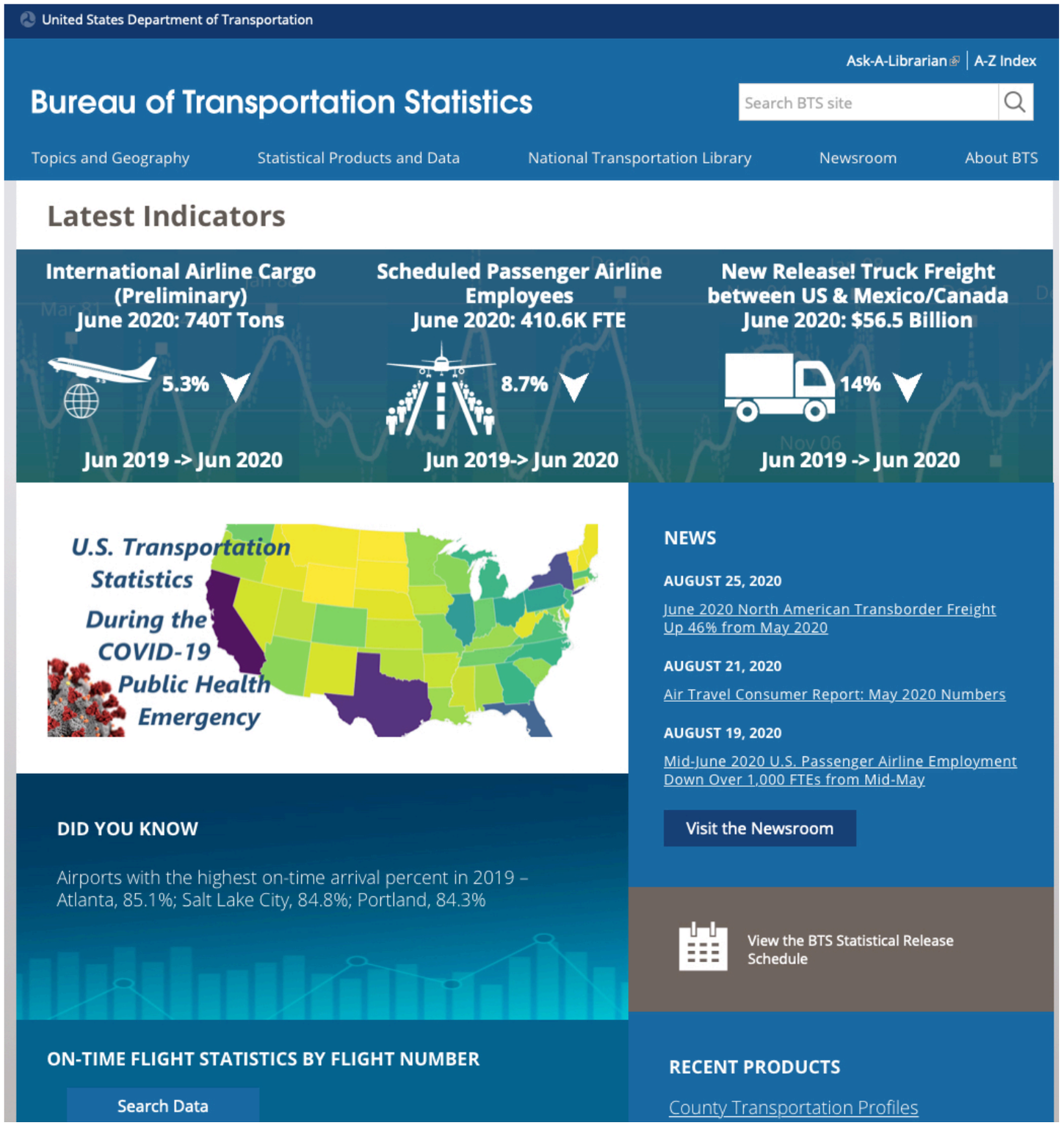
Source: Google Maps

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

Aircraft must land after **point B**

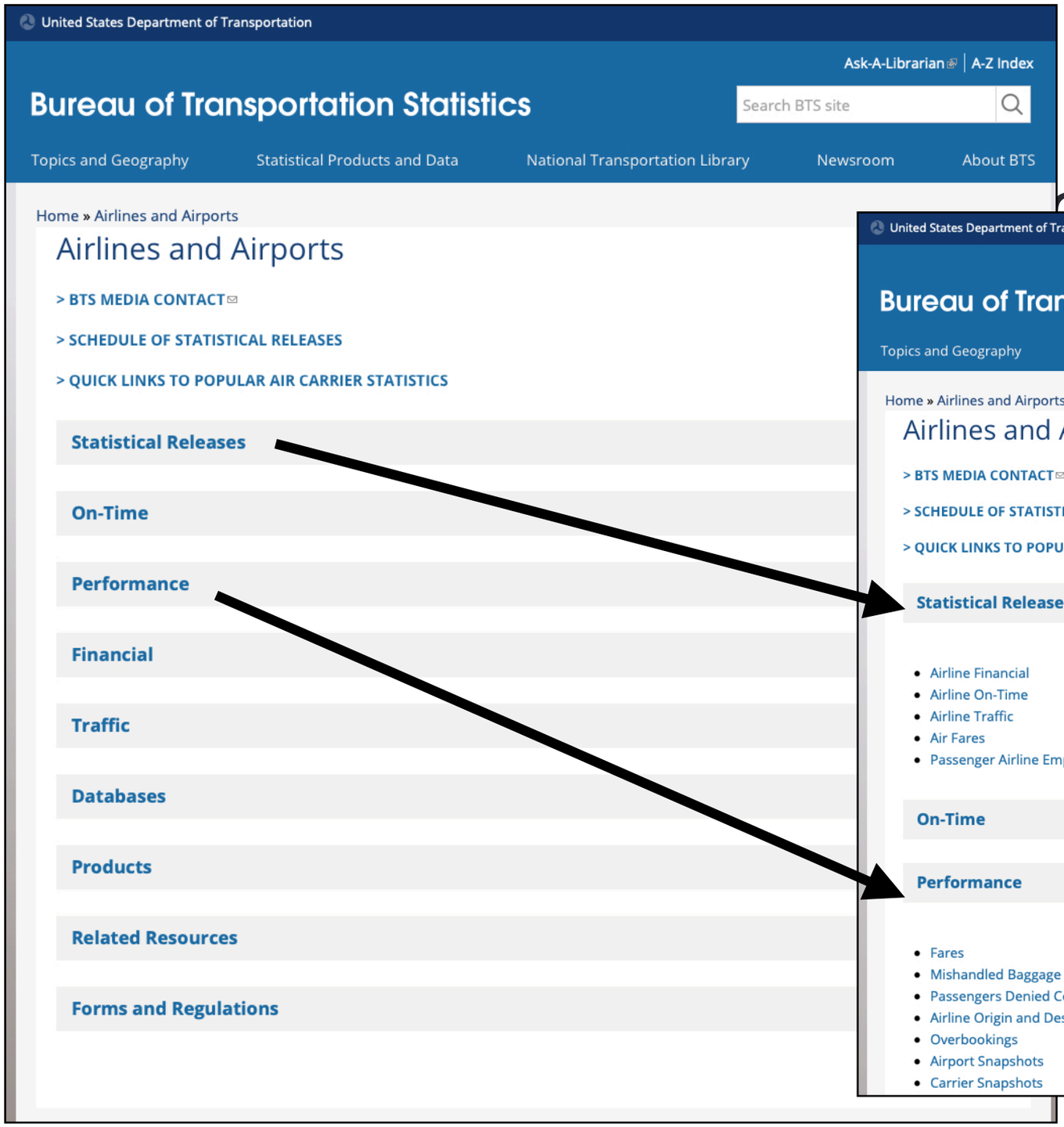
Bureau of Transportation Statistics

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

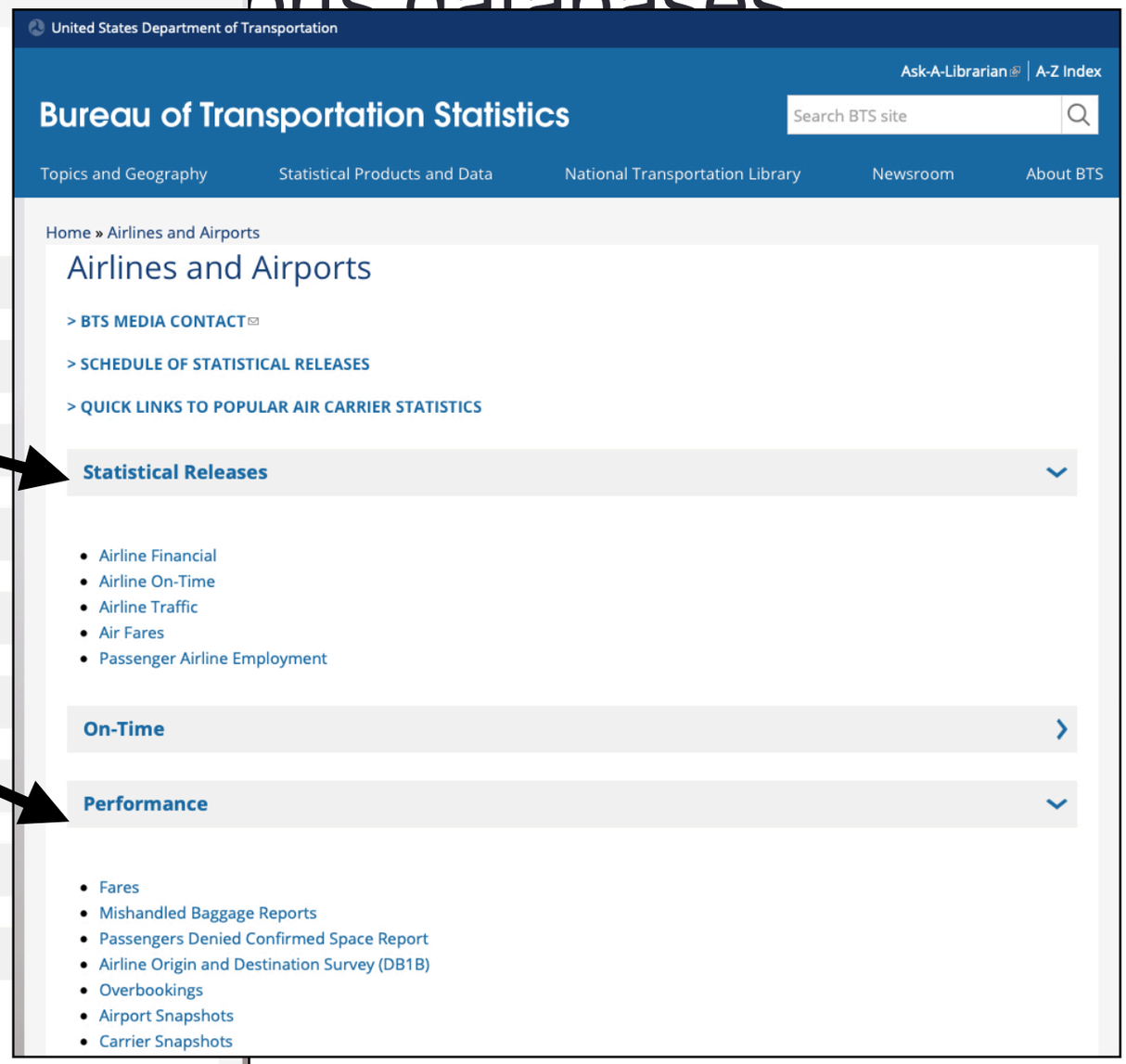


Airline and Airport Statistics

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



orts databases



Bureau of Transportation Statistics (http://www.transtats.bts.gov/)

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

BTS Airport Snapshot

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

Atlanta Airport

Atlanta served 45.94 million arrival passengers in 2019

Bureau of Transportation Statistics

Search BTS site

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

Select a month: January 2019

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

Submit

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

Show all airports (by state)

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)

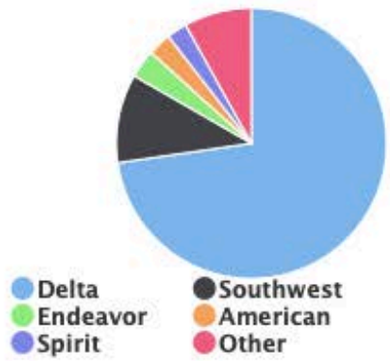
Passengers*	2018**	2019**	%Chg	Rank***
Arrival	44,346k	45,941k	3.60%	1
Departure	44,304k	45,865k	3.52%	1
Scheduled Flights				
Departures	387,193	394,569	1.90%	1
Freight/Mail (lb.) (Scheduled and Non-Scheduled)				
Total	655m	664m	1.28%	16
Carriers				
Scheduled	22	23	4.55%	

* Scheduled enplaned revenue passengers.
** 12 months ending January of each year.
*** Among 795 U.S. airports, 12 months ending January 2019

Carrier Shares for February 2018 - January 2019

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

Based on enplaned passengers(000) both arriving and departing.



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

Bureau of Transportation Statistics

Search BTS site

Topics and Geography | Statistical Products and Data | National Transportation Library | Newsroom | About BTS

BTS> TranStats

Select a month: May 2022

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

Select an airport: Atlanta, GA: Hartsfield-Jackson Atlanta International

Submit

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

Vero Beach, FL: Vero Beach Regional (VRB)
West Palm Beach/Palm Beach, FL: Palm Beach International (PBI)

Georgia
Albany, GA: Southwest Georgia Regional (ABY)
Athens, GA: Athens/Ben Epps (AHN)
Atlanta, GA: Hartsfield-Jackson Atlanta International (ATL)
Augusta, GA: Augusta Regional at Bush Field (AGS)
Brunswick, GA: Brunswick Golden Isles (BQK)
Columbus, GA: Columbus Airport (CSG)
Macon, GA: Middle Georgia Regional (MCN)
Savannah, GA: Savannah/Hilton Head International (SAV)
Valdosta, GA: Valdosta Regional (VLD)

Virgin
Charlo
Lynch
(LYH)
Newpo
News/Williamsburg International (PHF)
Norfolk, VA: Norfolk International (ORF)
Norfolk, VA: Norfolk NS (NGU)
Richmond, VA: Richmond International (RIC)
Roanoke, VA: Roanoke Blacksburg Regional Woodrum Field (ROA)
Staunton, VA: Shenandoah Valley Regional (SHD)
Washington, DC: Ronald Reagan Washington National (DCA)
Washington, DC: Washington Dulles International (IAD)

Roanoke/Blacksburg Regional Airport

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: August 2019 Select a carrier: Delta Air Lines Submit

(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

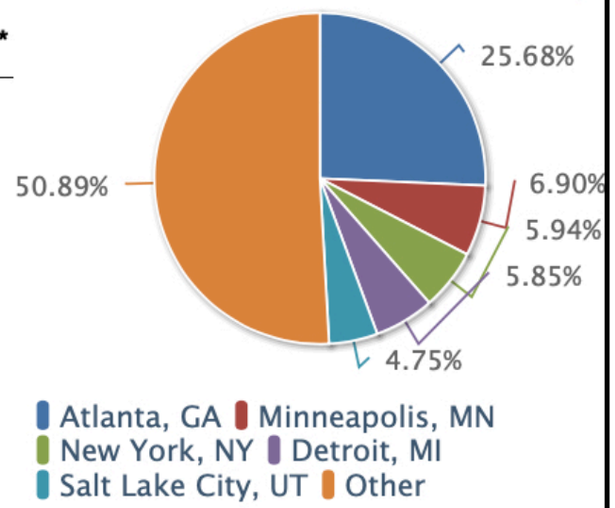
Summary Data (U.S. Airports, 12 Months Ending August)

	2018	2019	%Chg	Rank[1]
Passengers	124,117k	132,945k	7.11%	2
Departures	936k	975k	4.23%	2
RPM 2	119,266m	128,323m	7.59%	2
ASM 3	137,615m	146,549m	6.49%	3
Loadfactor	86.7%	87.6%	0.90 pts	1
Air Cargo 4	463m	425m	-8.14%	2
Markets Served	163	161	-1.23%	
Share 5	16.82%	17.31%	0.49 pts	2

1 Among 0 passenger carriers for 2019
2 Revenue Passenger Miles
3 Available Seat Miles
4 Air Cargo is the sum of Freight and Mail in pounds.

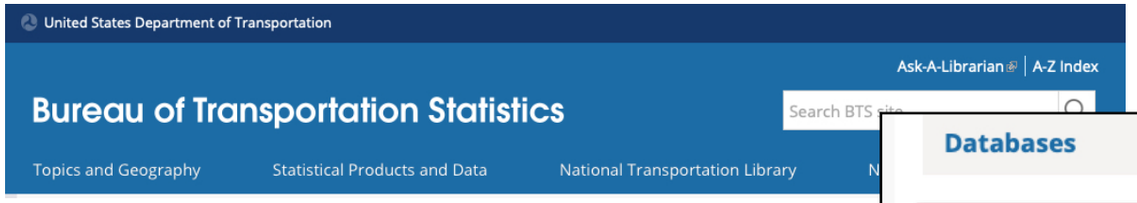
Top Domestic Markets* (September 2018 - August 2019)

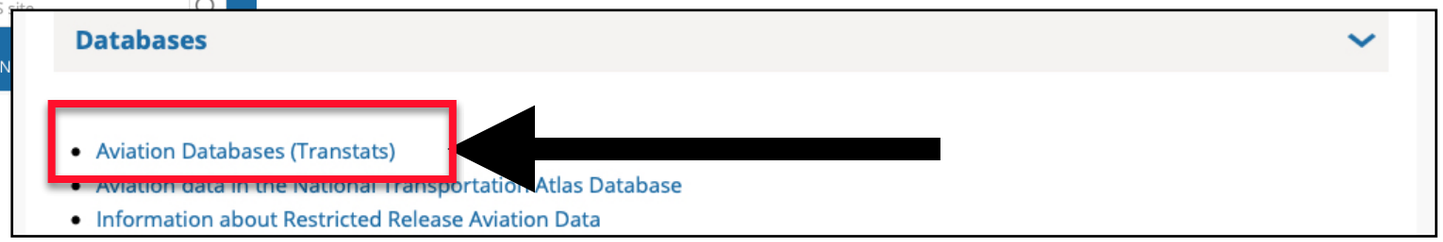
Market	Passengers	Share**
Atlanta, GA	34.14m	72.89%
Minneapolis, MN	9.17m	53.22%
New York, NY	7.89m	27.87%
Detroit, MI	7.77m	48.71%
Salt Lake City, UT	6.31m	52.08%
Other	67.66m	9.97%



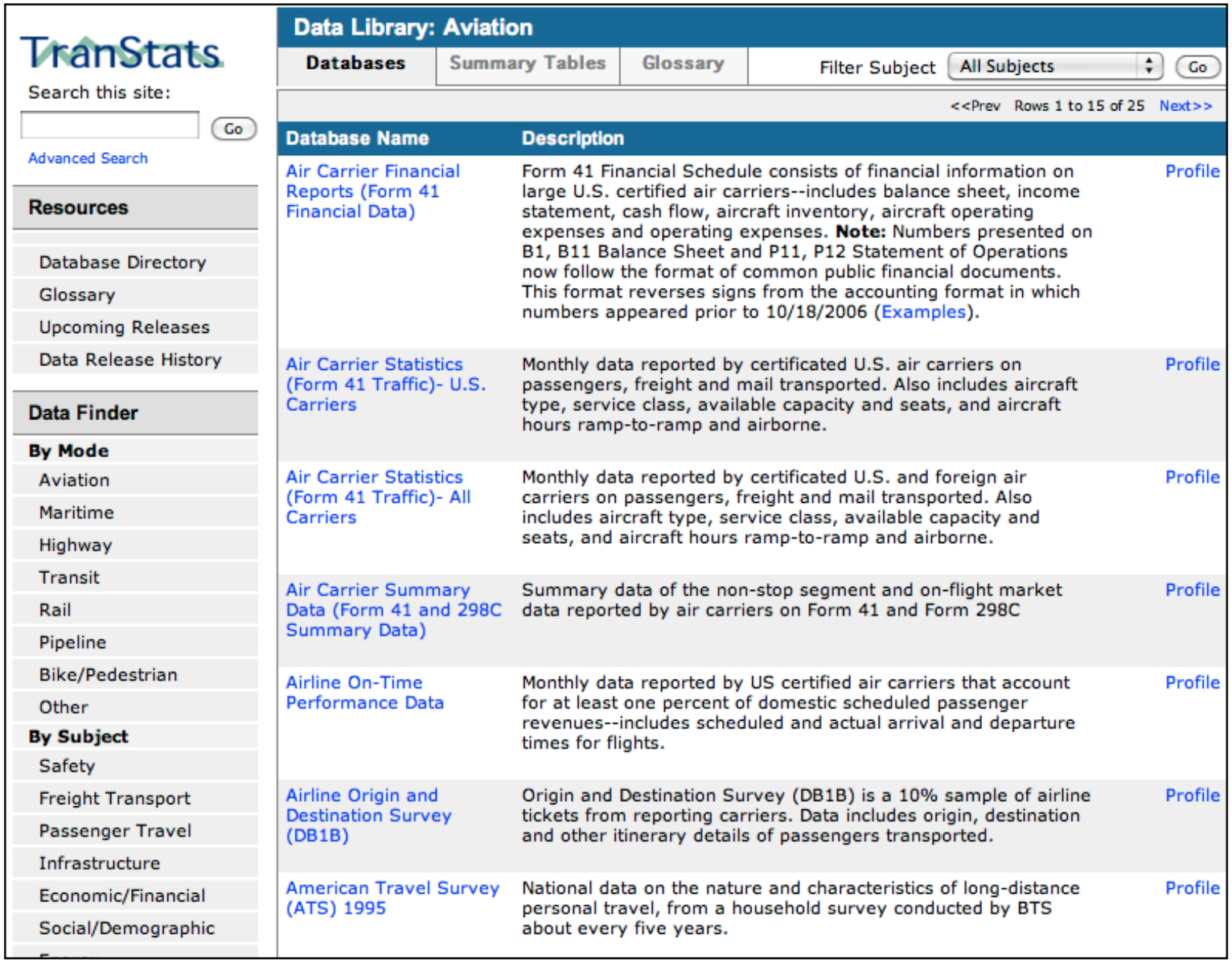
* Based on total enplaned passengers at all airports in a city.
** The table shows the carrier's share in each of the markets.
The pie chart shows each market's share in the carrier's total air passengers.

Bureau of Transportation Statistics (BTS)



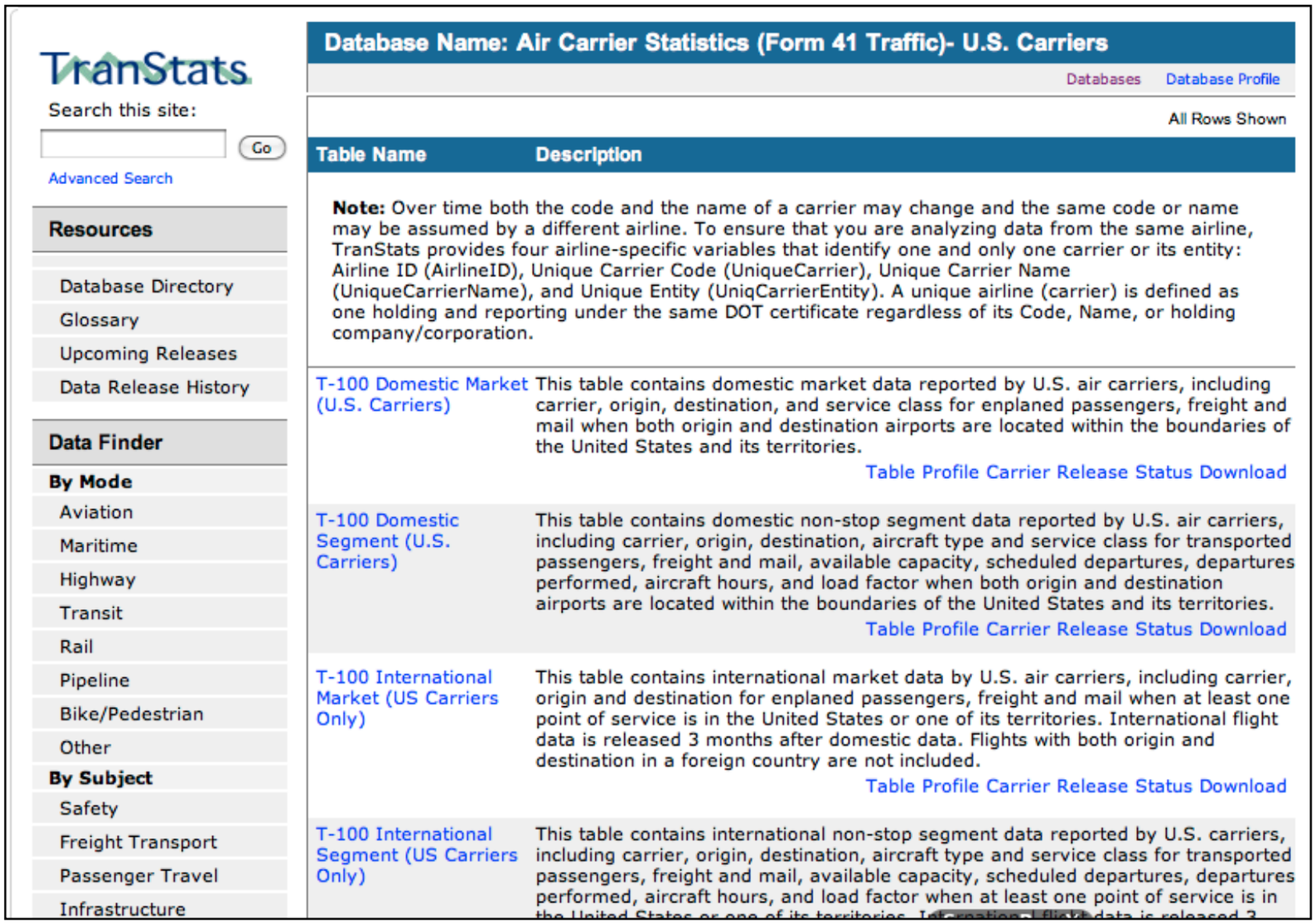


- Dedicated section of the database to aviation
- Air carrier statistics (form 41) (T100)
- Airline on-time performance
- Airline origin-destination survey (10% sample of tickets sold) called DB1B database



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



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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Home

Schedule B-43 Aircraft Inventory (2009)

By Aircraft Manufacturer and Aircraft Type

Excel | CSV

Carriers	Total Aircraft	Average Aircraft Age (2009)
Cargo		
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:

Go

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: Delta Air Lines

Select an airport: All Submit

Origin

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

Destination

* 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.

Download

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
2002	**TOTAL**	**99,461,315**	**31,221,978**	**130,683,293**
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 (Translate)
- Aviation data in the National Transportation Atlas Database
- Information about Restricted Release Aviation Data

1–10 of 12 results — Most Recent

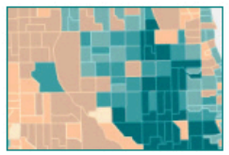
139 attributes | 14912 locations

Runway Ends *(from Open Data)*
USDOT_BTS
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...

107 attributes | 19850 locations

Airports *(from Open Data)*
USDOT_BTS
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...

6 attributes | 404 locations



Intermodal Freight Facilities – Air to Truck *(from Open Data)*
USDOT_BTS
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.

140 attributes | 7308 locations

Runway Lines *(from Open Data - Transportation Infrastructure)*
USDOT_BTS
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...

138 attributes | 11931 locations

Runway Nonspatial *(from Open Data - Transportation Infrastructure)*
USDOT_BTS
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...

139 attributes | 4398 locations

Runway Points *(from Open Data)*

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

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

About

Open Data

By USDOT_BTS
Updated: 18 days ago
Data available to the open data portal.

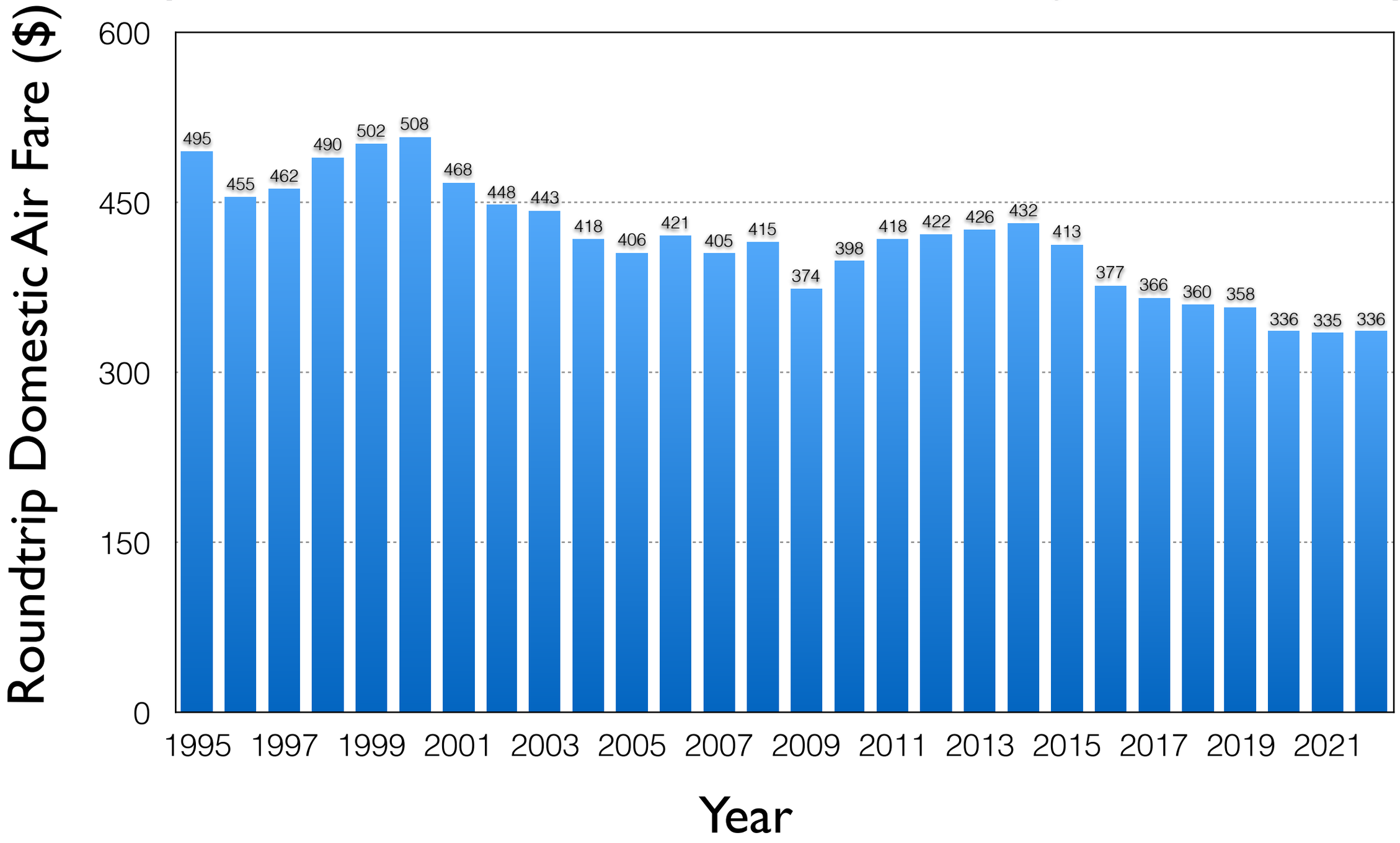
Source https://geo.dot.gov/server/rest/services/NTA
Metadata Airports
License No license specified

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

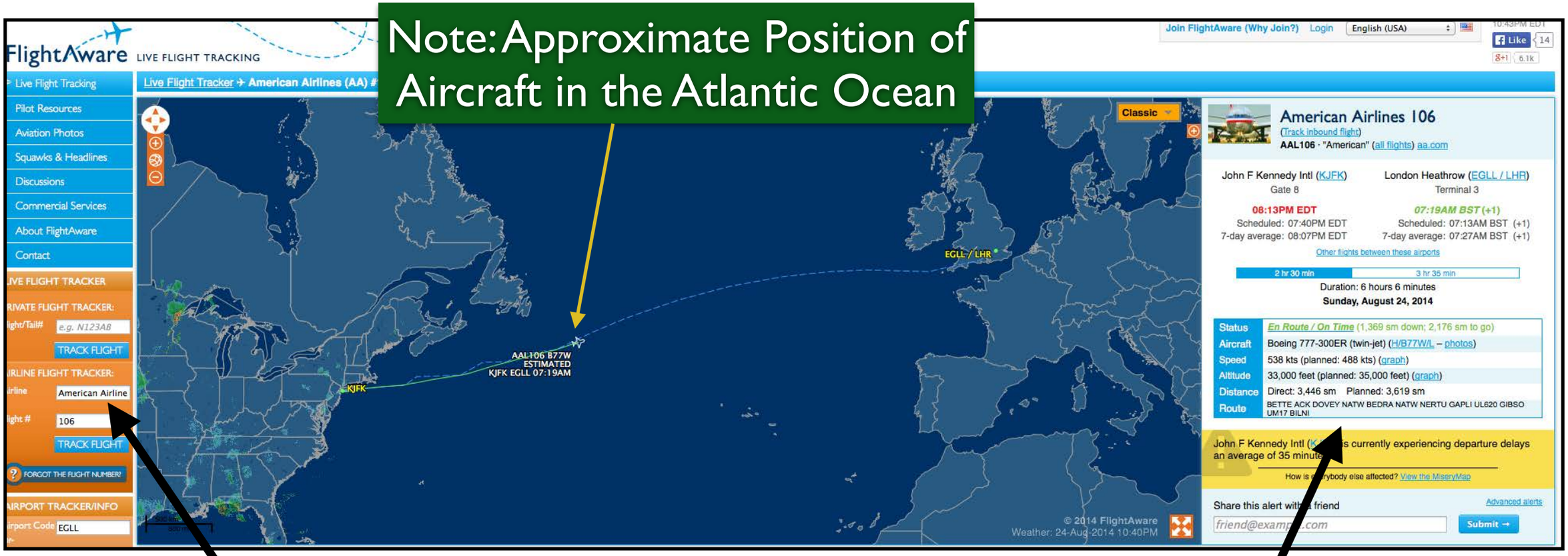
Bureau of Transportation Statistics

(Air Fares over Time - Inflation Adjusted $2020)



Flight Tracking flightaware.com

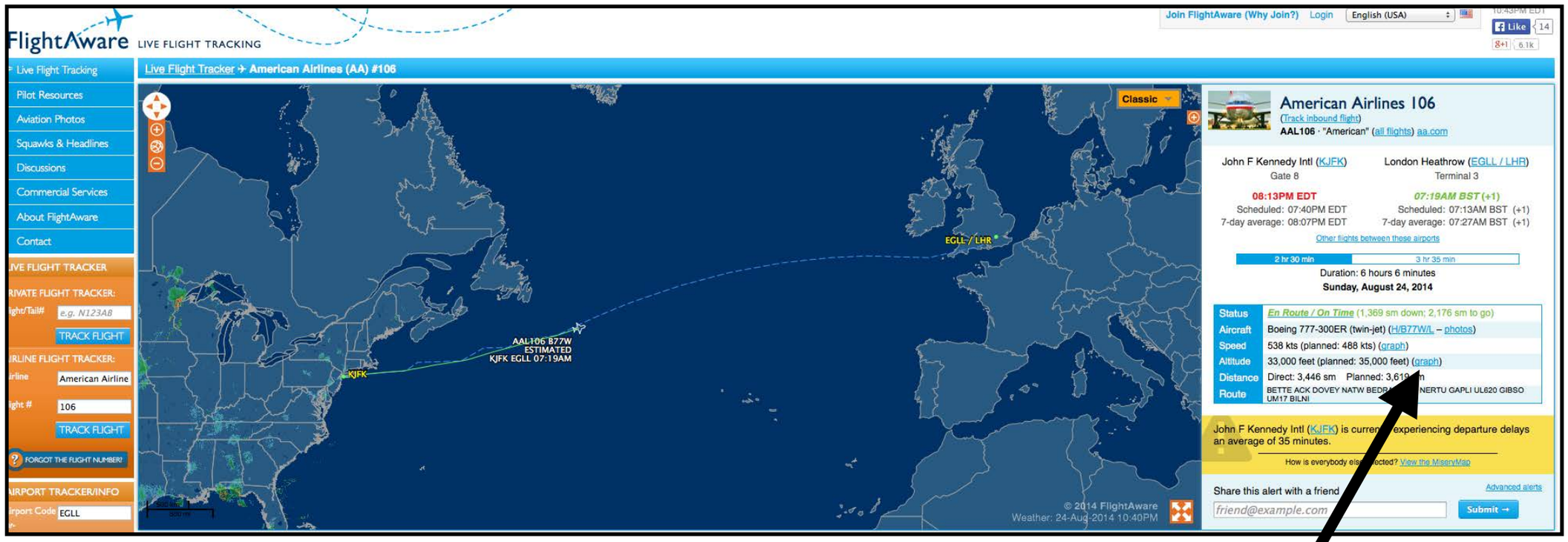
Note: Approximate Position of Aircraft in the Atlantic Ocean

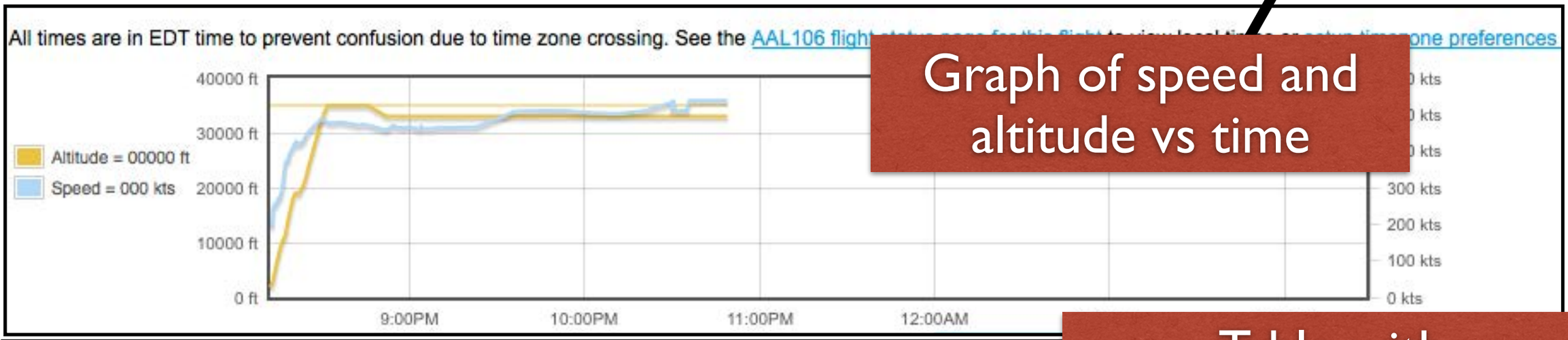


Tracking American Airlines Flight 106

JFK-LHR
New York Kennedy to London Heatrow airports

Flight Plan Information





Graph of speed and altitude vs time

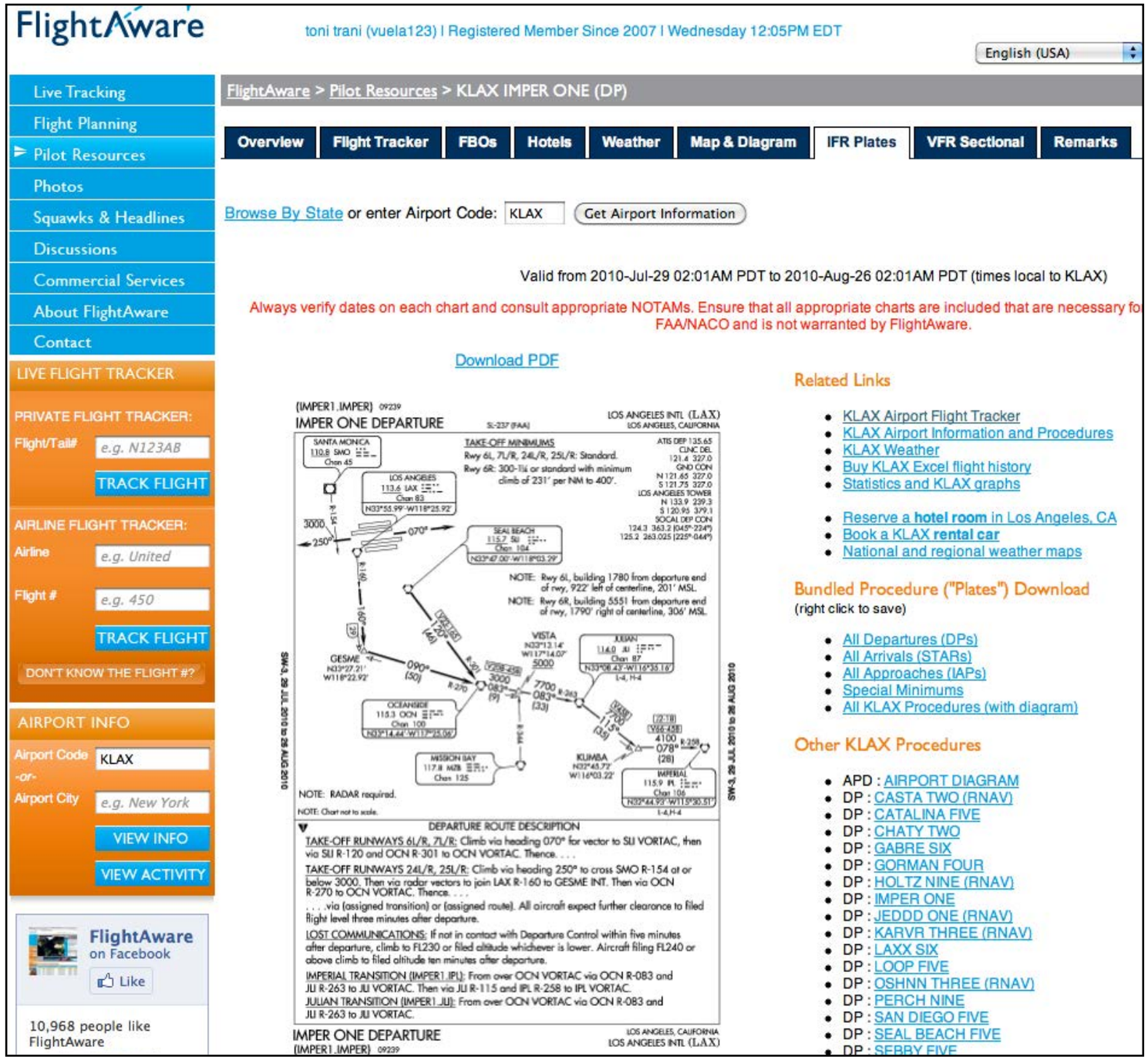
Time	Position		Orientation		Groundspeed		Altitude	
EDT	Latitude	Longitude	Course	Direction	KTS	MPH	feet	Ra
08:12PM	40.6039	-73.7472	145°	Southeast	197	227	1,800	
08:13PM	40.5796	-73.7148	145°	Southeast	197	227	2,500	
08:13PM	40.5749	-73.6917	100°	East	242	278	2,900	
08:13PM	40.5731	-73.6710	95°	East	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

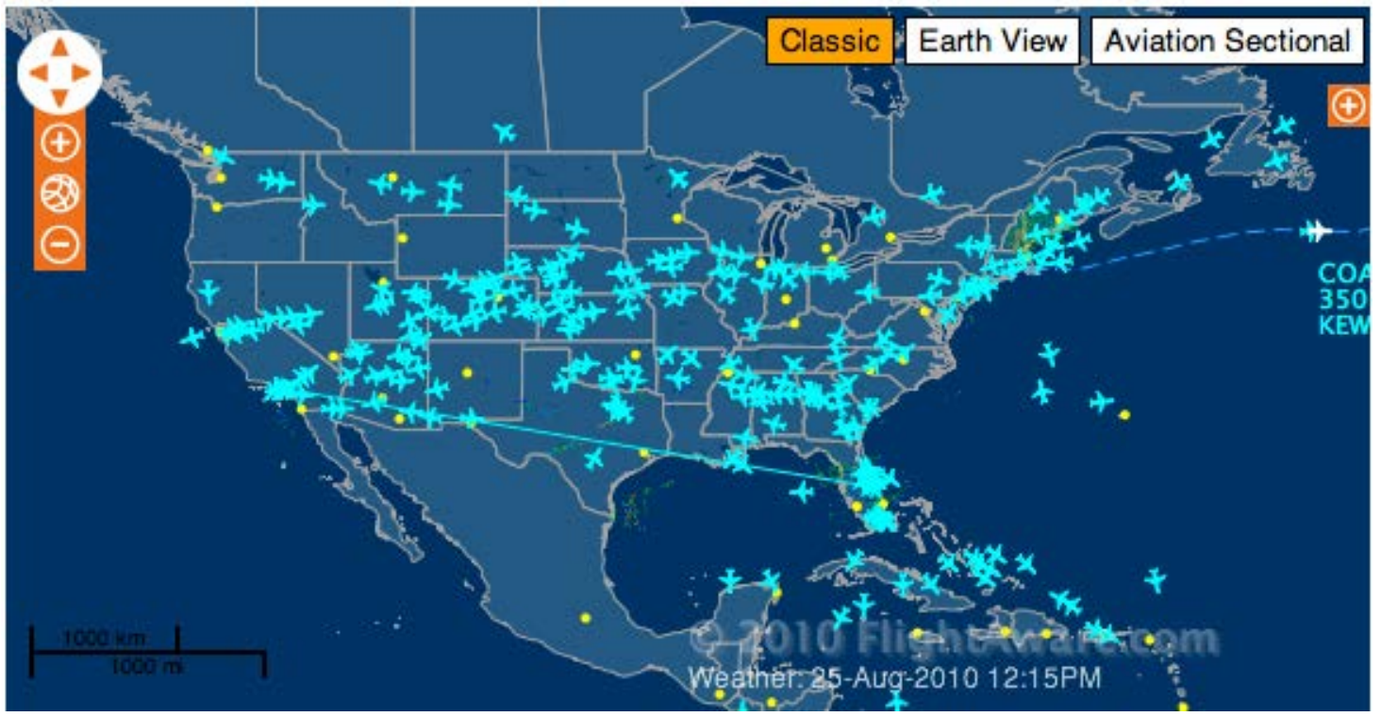
Flight Tracking Information (flightaware.com)

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

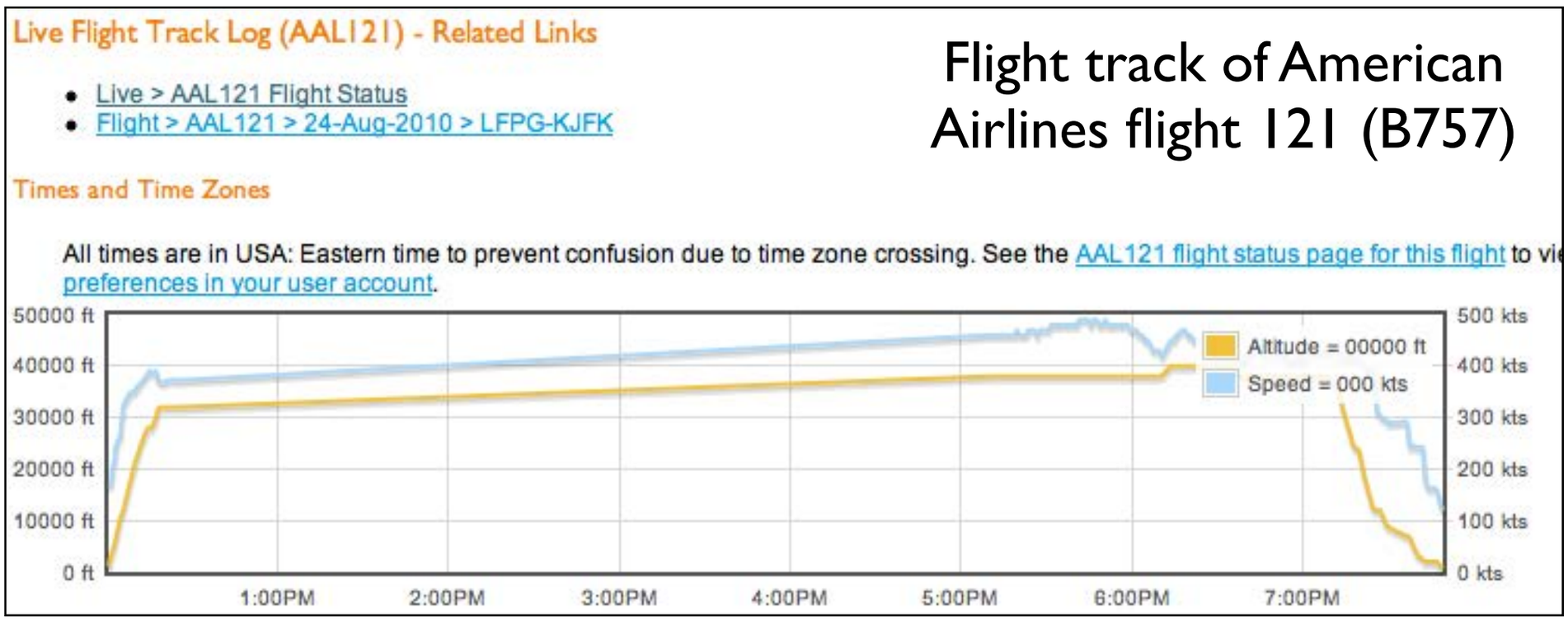
LAX IFR Departure Procedure Imper One



Flightaware.com

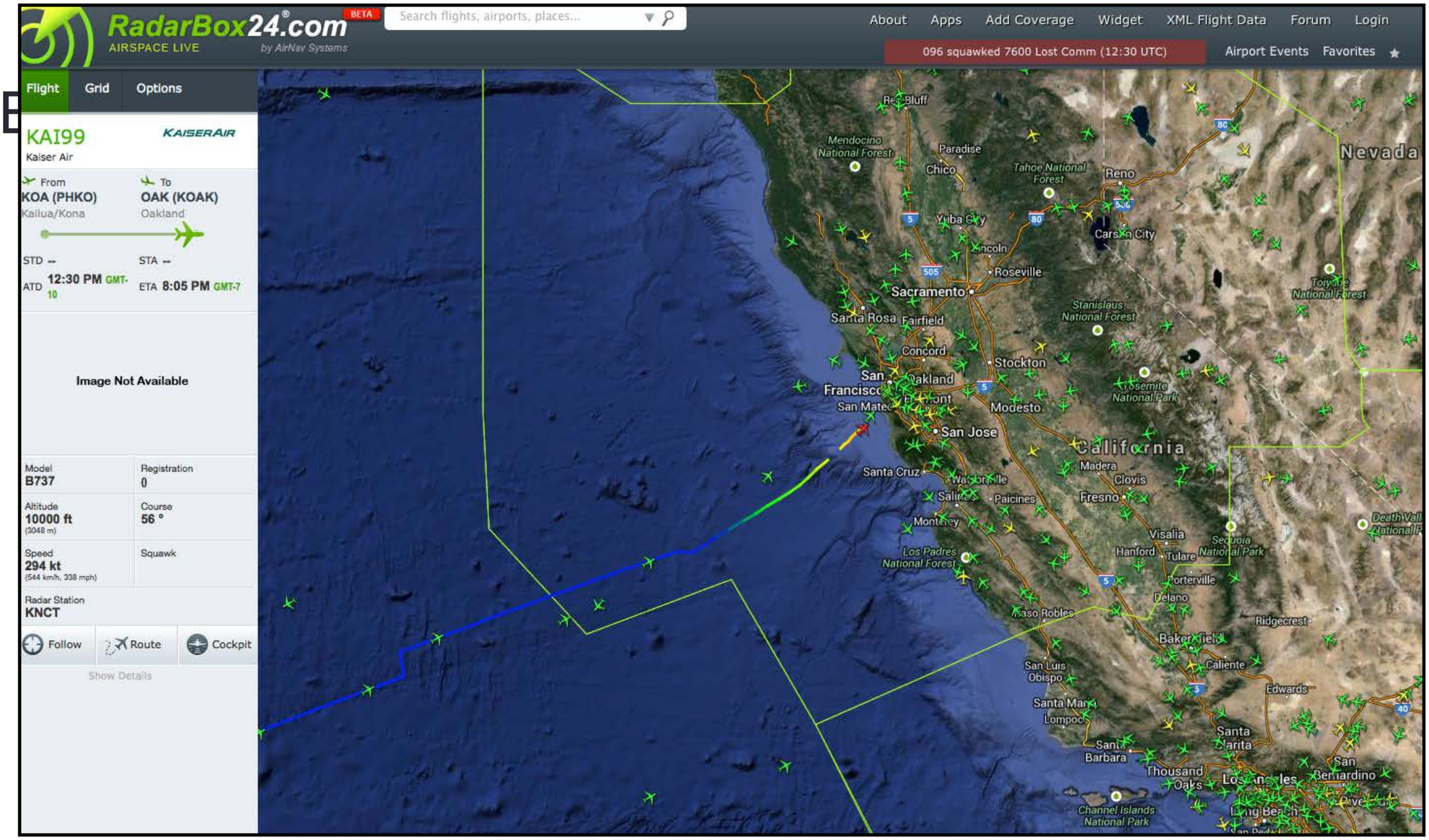


Tracking all Boeing 757 flights in the NAS



Flight track of American Airlines flight 121 (B757)

Flight Tracking Information
(http://www.radarbox24.com)

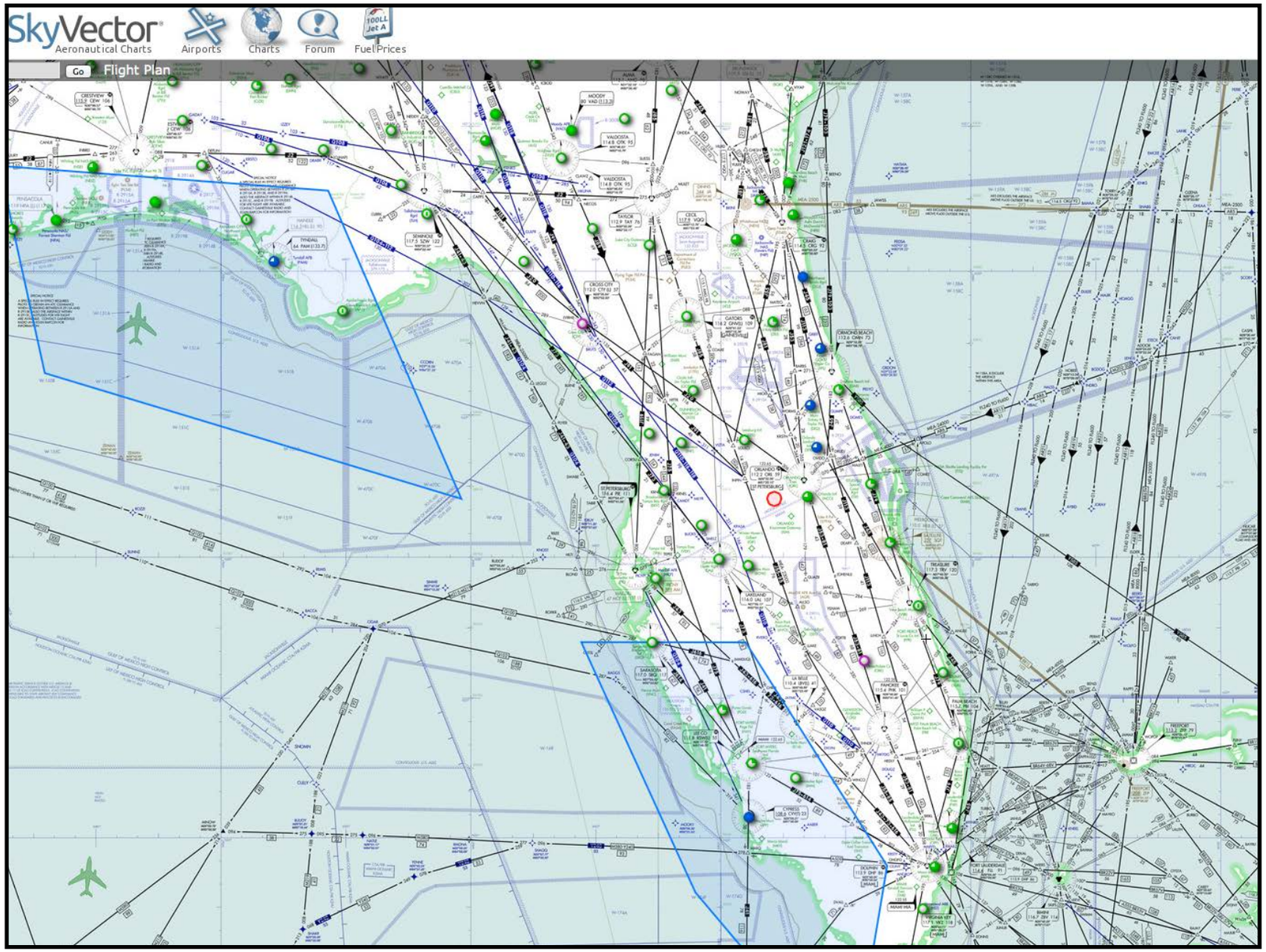


Flight Tracking Information
(http://www.radarbox24.com)

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

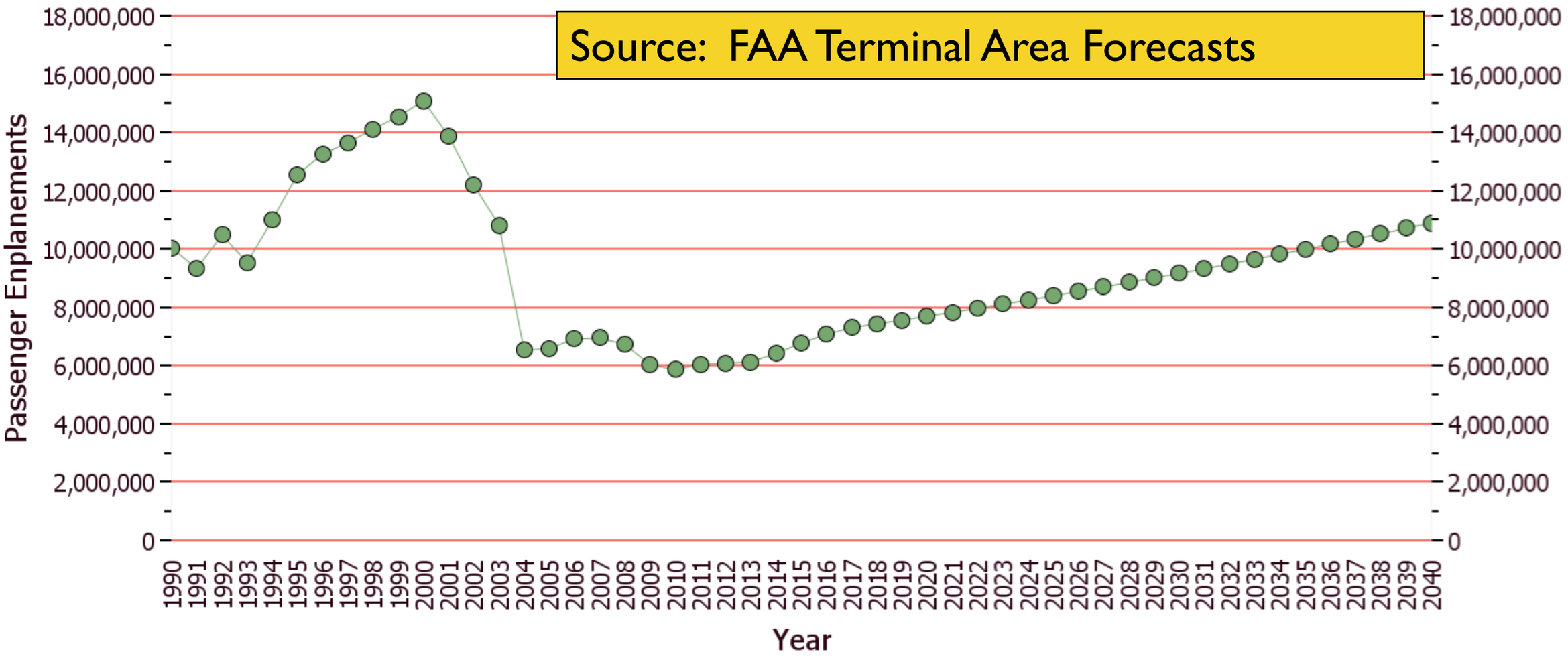
Reporting Systems
- Business Jet Reports

FAA Operations and Performance Database

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

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.

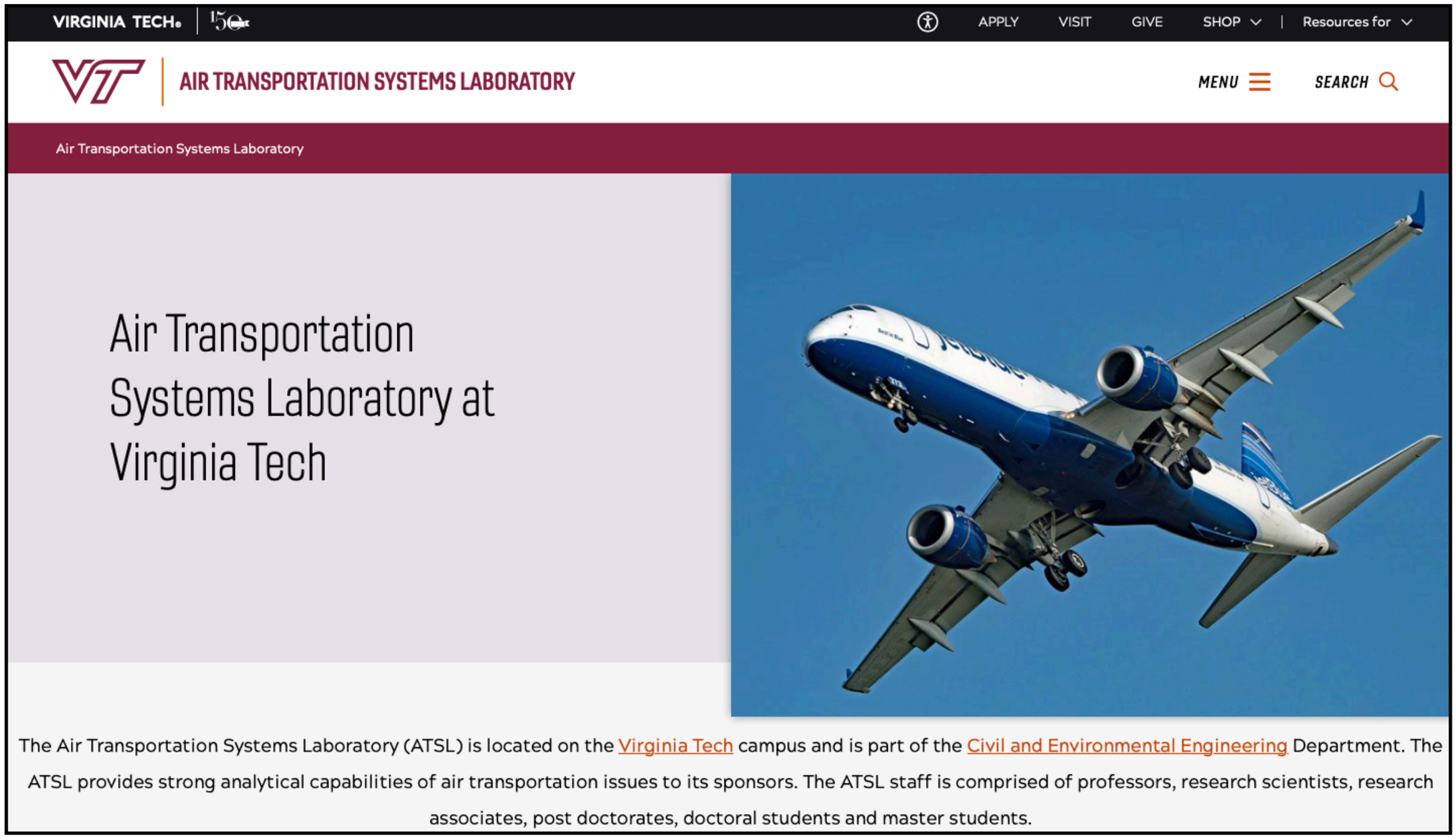
Aviation Performance Metrics : Airport Analysis : All Flights Report

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

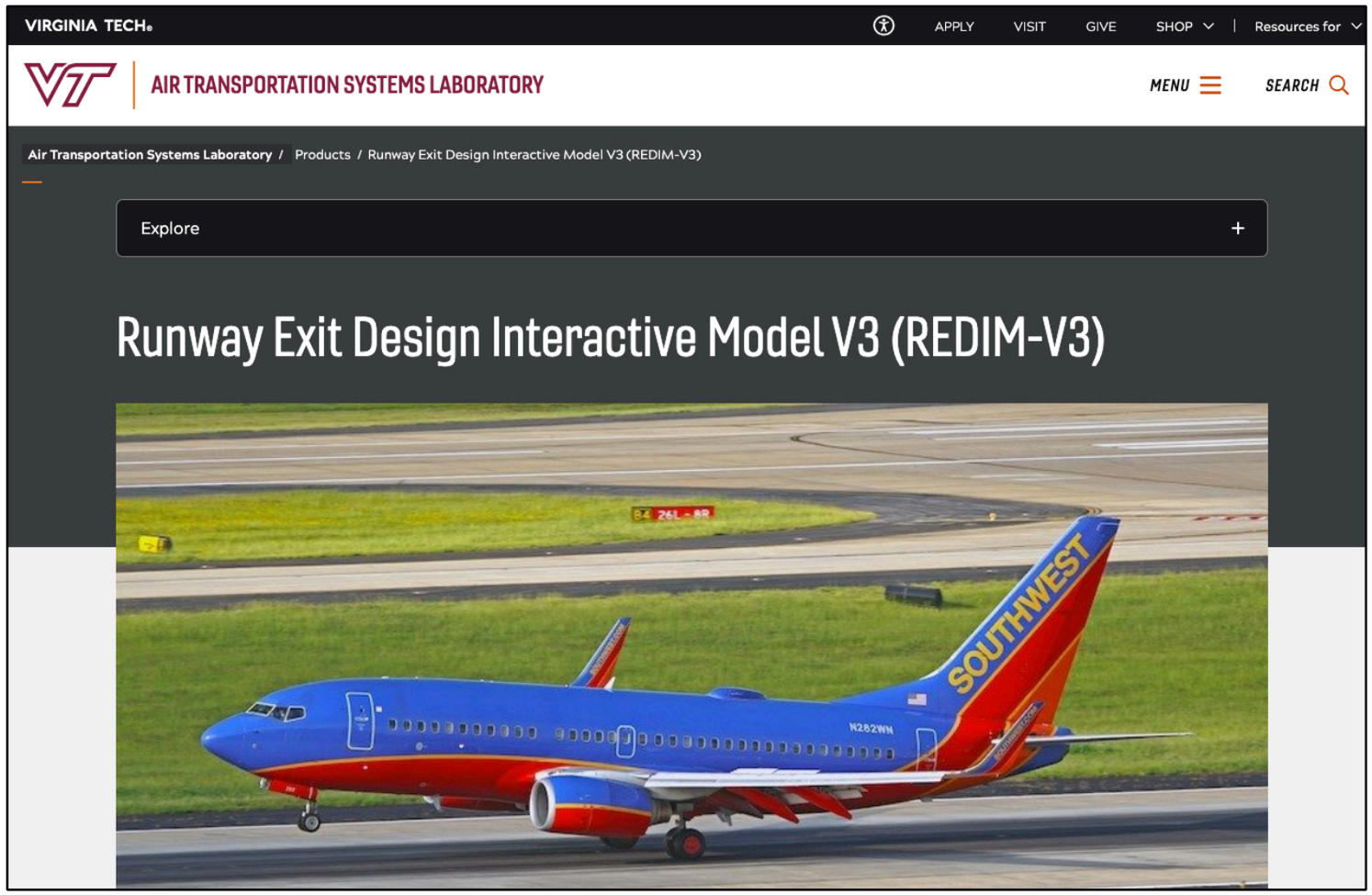
Aircraft Landing Events Database

Database Created at the Virginia Tech Air Transportation Lab



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

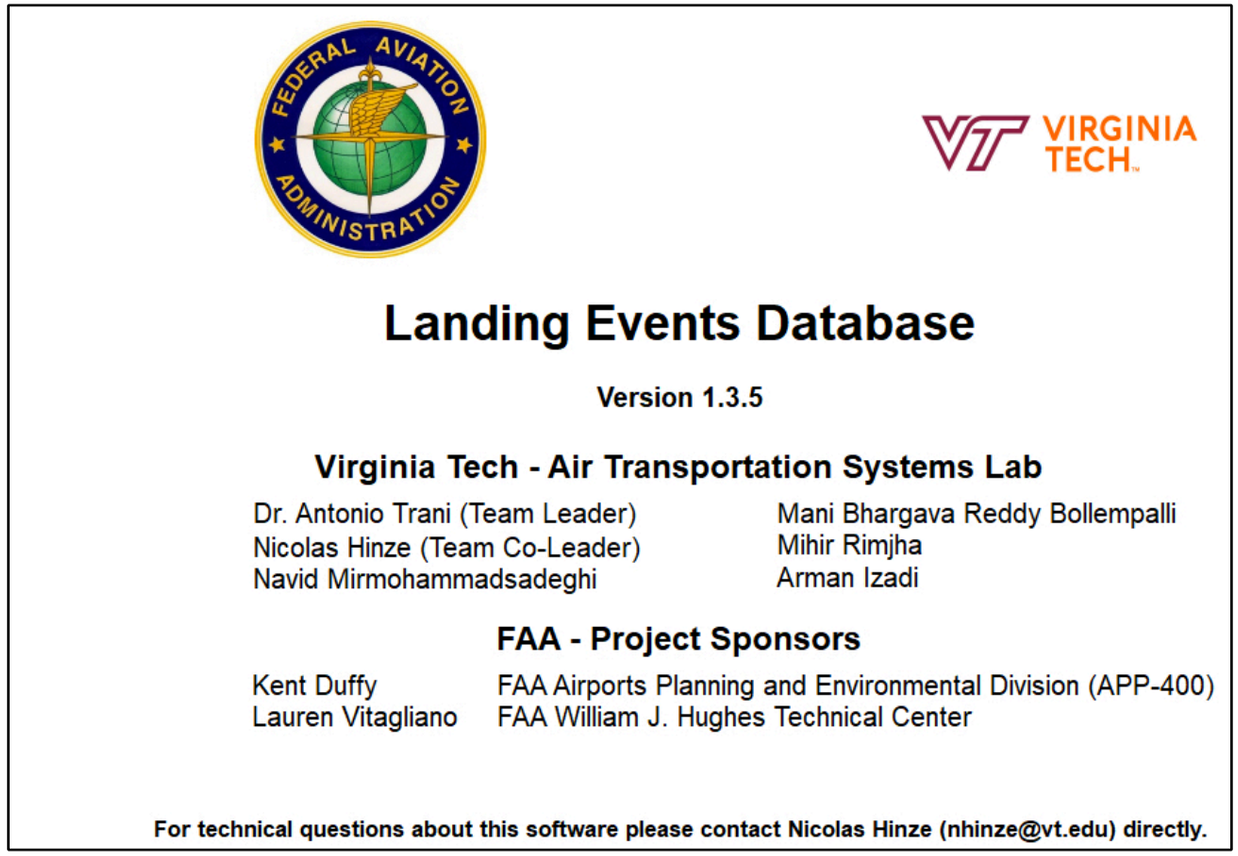
Detailed Documentation for REDIM 3

- 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



VIRGINIA TECH

Landing Events Database

Version 1.3.5

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 — 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) 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

Landing Event Database Tool Version 1.3.5

Landing Events Database

Version 1.3.5

Virginia Tech - Air Transportation Systems Lab

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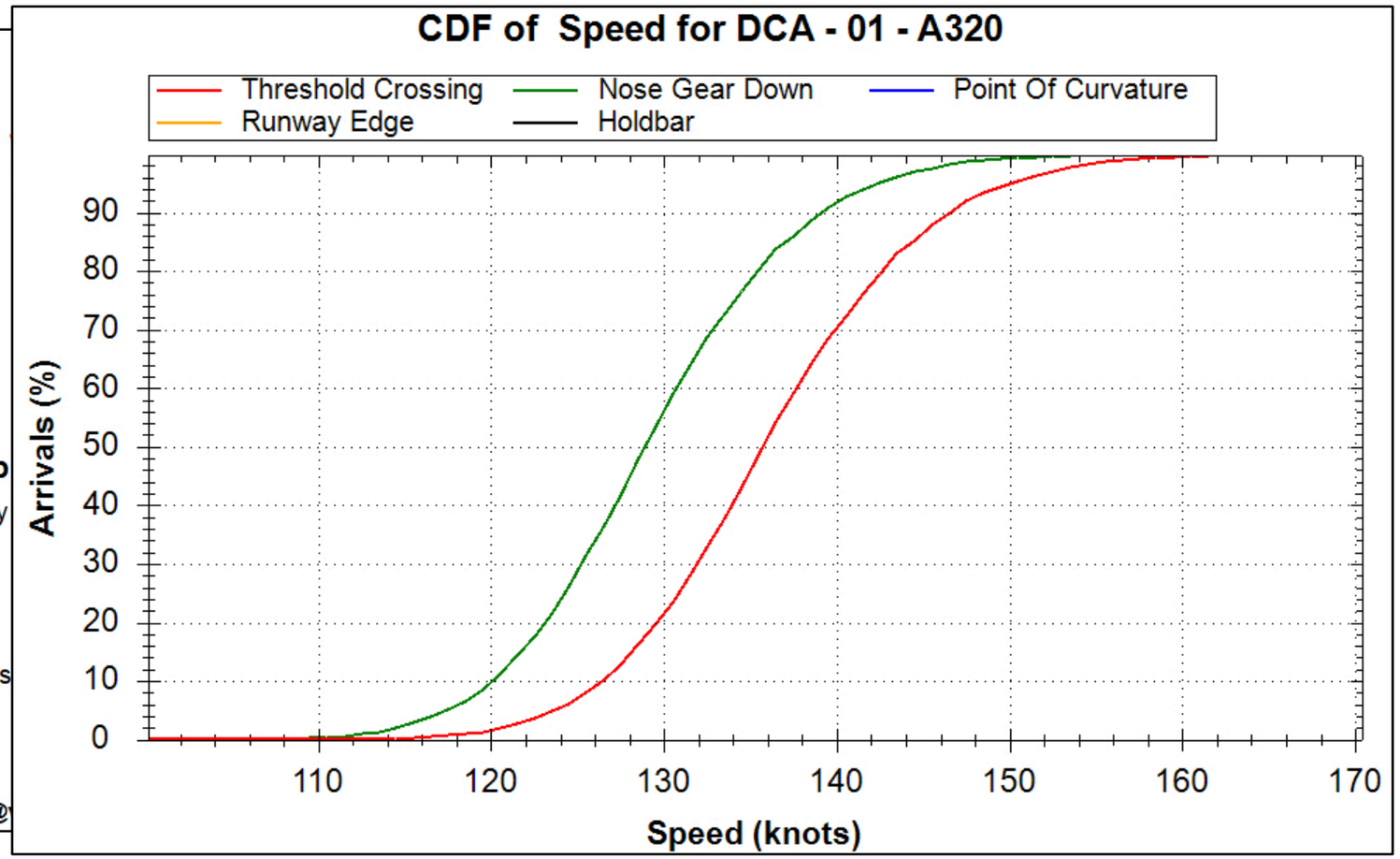
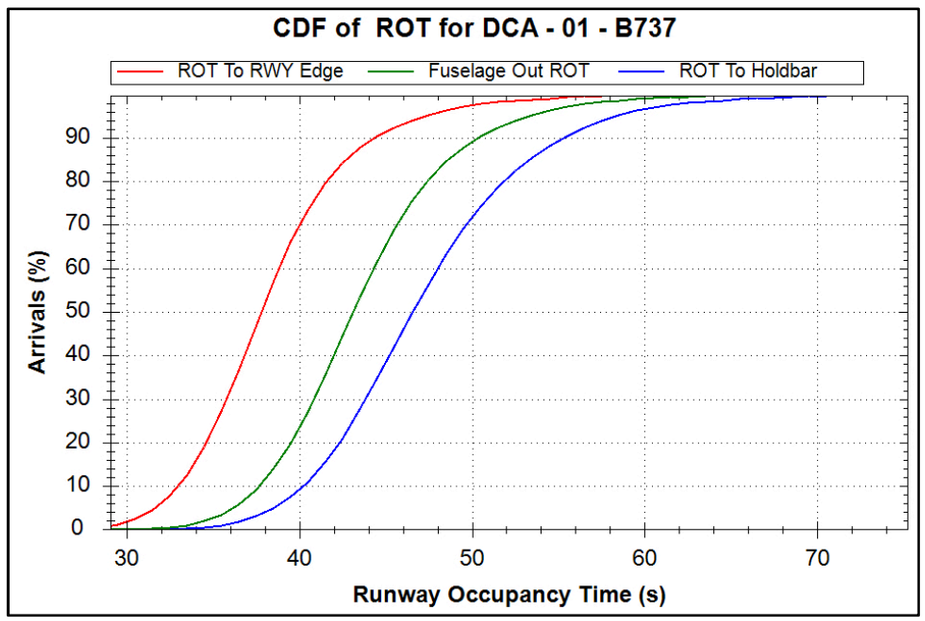


Landing database client can be downloaded at:

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

Filters by:
Carrier, Aircraft, Runway, Runway Exit, and Date Range

Landing track follows the aircraft up to the last position reported (near the gate location)

Landing Event Database Tool (1)

Analysis	Purpose	Metrics and Ready-Made Query Options
Aircraft Mix	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
Runway Occupancy Time	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
Speed	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
Nose Gear Location	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
Deceleration	Provides two values of aircraft deceleration on the runway: Nominal Nominal location to point of curvature (Nominal to PC)	Average deceleration (in m/s2) by runway, runway exit and aircraft Median deceleration (in m/s2) by runway, runway exit and aircraft Probability Density Function (PDF) of deceleration (in m/s2) by runway, runway exit and aircraft (both average and median values can be plotted) Cumulative density function of aircraft deceleration (in m/s2) by runway, runway exit and aircraft (both average and median values can be plotted)
Raw Data	Provides detailed information (in a table) on 30 key parameters for every landing contained in the Landing Events Database. Provides graphical information of every landing in the database. Provides a graphical depiction of individual landings in a Microsoft NAVTEQ map layer (bottom viewport)	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. Speed-distance profile of each landing event Speed-time profile of each landing event Acceleration-time profile of each landing event Acceleration-distance profile of each landing event Processed numerical data with speed, acceleration, distance and time for individual landings.
Statistics	Summarizes the landing statistics processed by airport by month.	Total landing records Valid records Number of records with missing parameters Number of records with unreasonable parameters Records with no associated runway Go-around records

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...	12/9/2			27.7	4,961		5,965		48.7	54.0

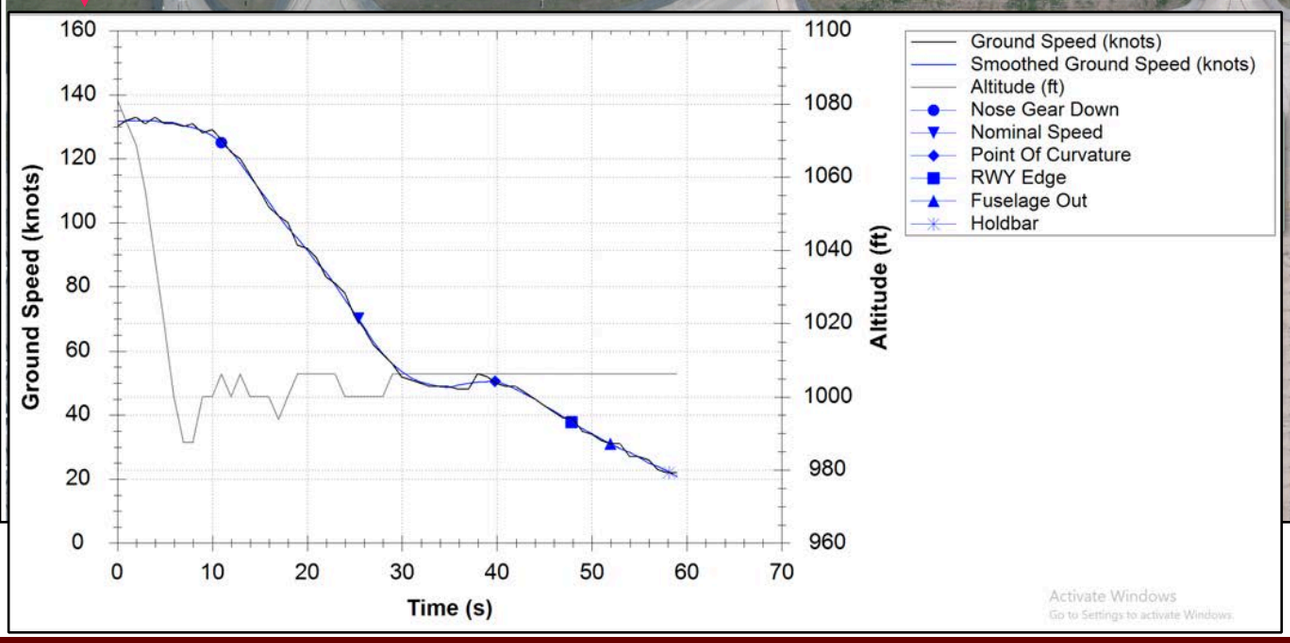
Map | Speed vs Time | Speed vs Distance | Acceleration vs Time | Acceleration vs Distance | Data

Every landing can be examined in detail (Airbus A319 example)

Estimated nose gear touchdown location (125 knots)

70-knot nominal speed

Runway exit speed 50.6 knots

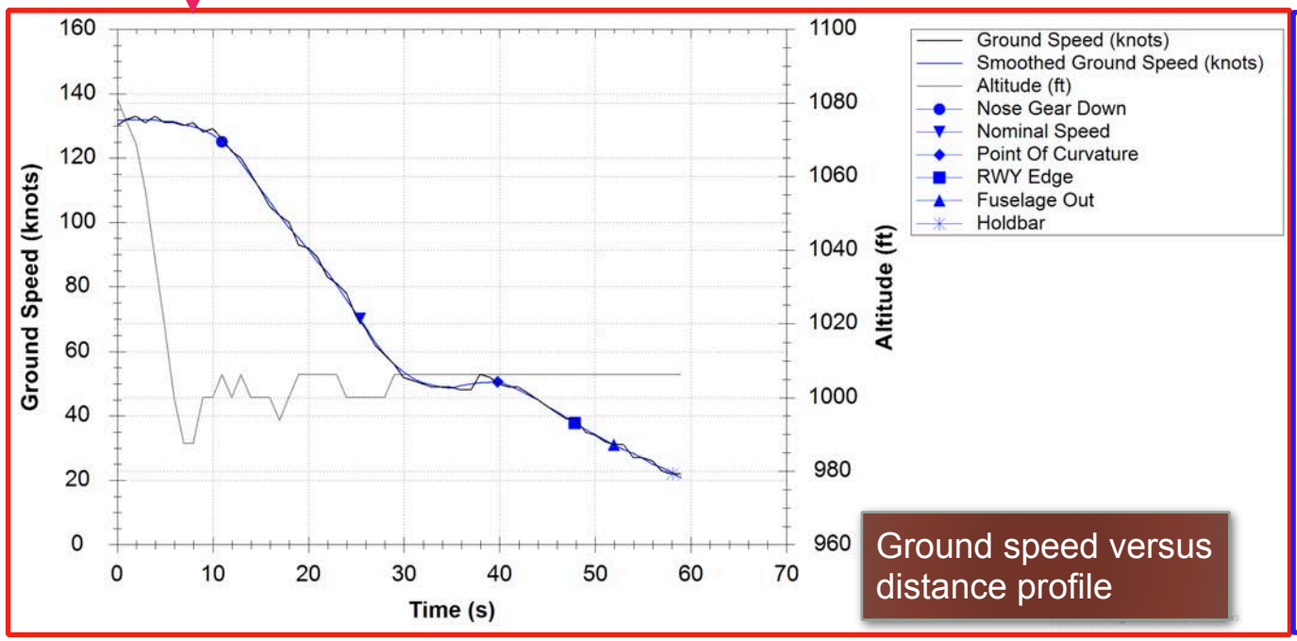


Landing Database Raw Data Viewer

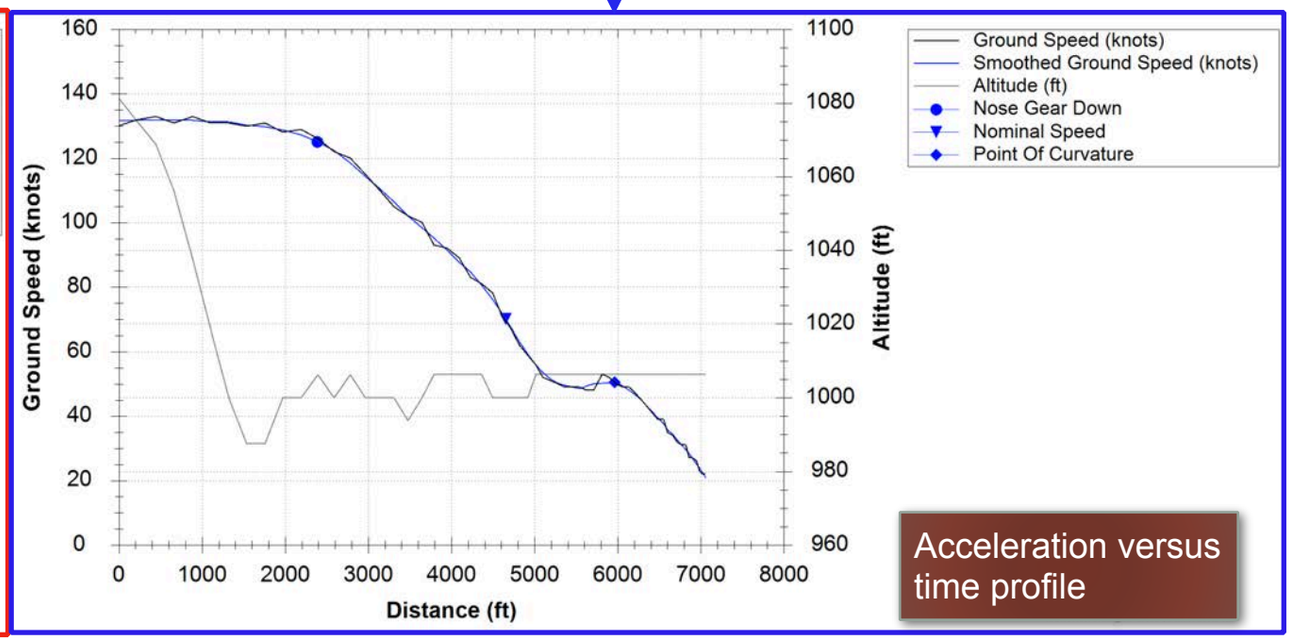
Runway: 08L | Exit: | Carrier: DAL | Aircraft: A319 | Arrival | Valid Flights | 12/ 1/2019 to 1/ 1/2021 | Query | Export

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



Ground speed versus distance profile



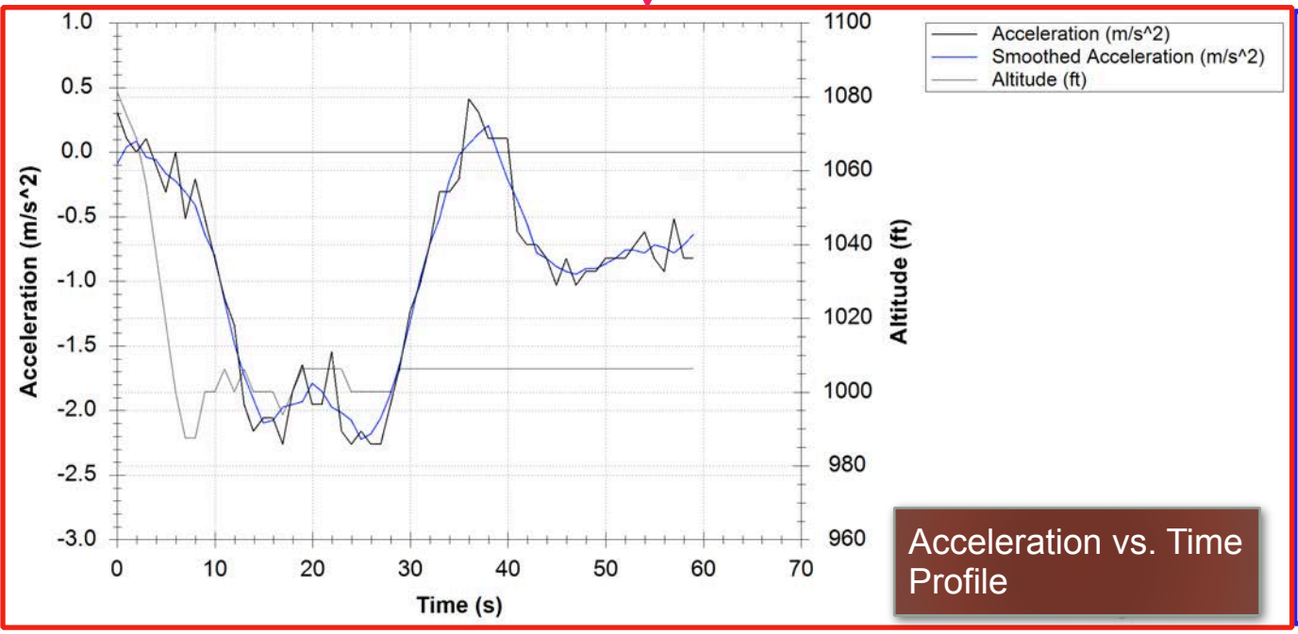
Acceleration versus time profile

Landing Database Raw Data Viewer

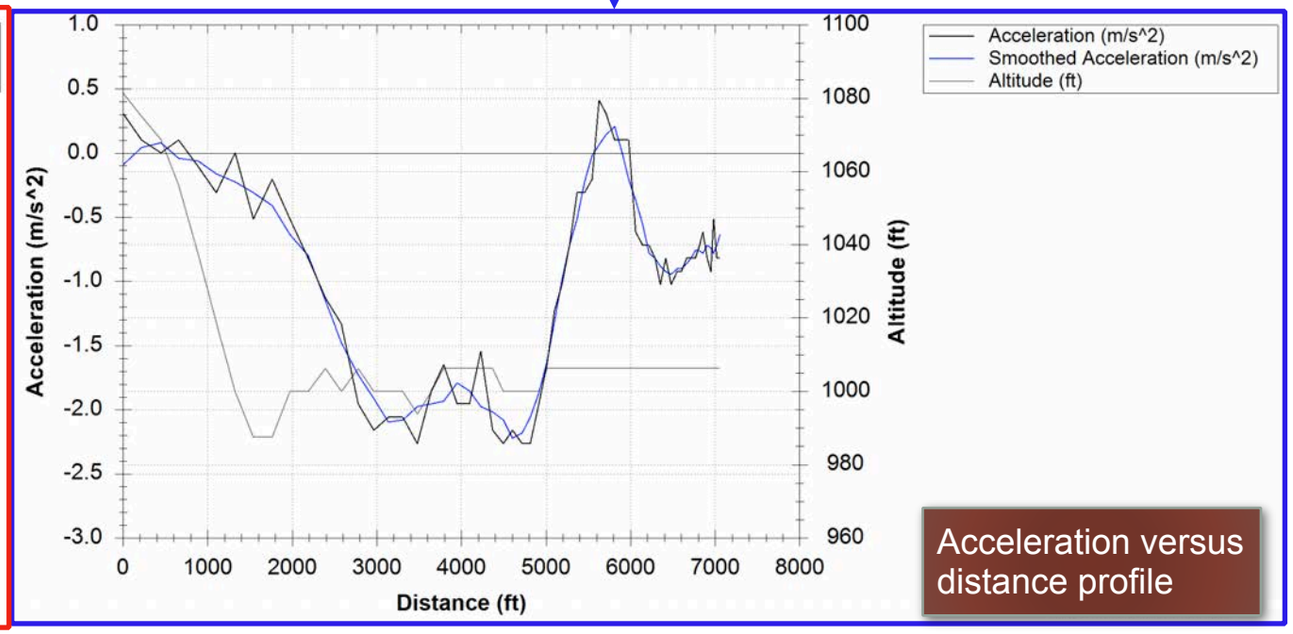
Runway: 08L | Exit: | Carrier: DAL | Aircraft: A319 | Arrival | Valid Flights | 12/ 1/2019 to 1/ 1/2021 | Query | Export

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



Acceleration vs. Time Profile



Acceleration versus distance profile

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

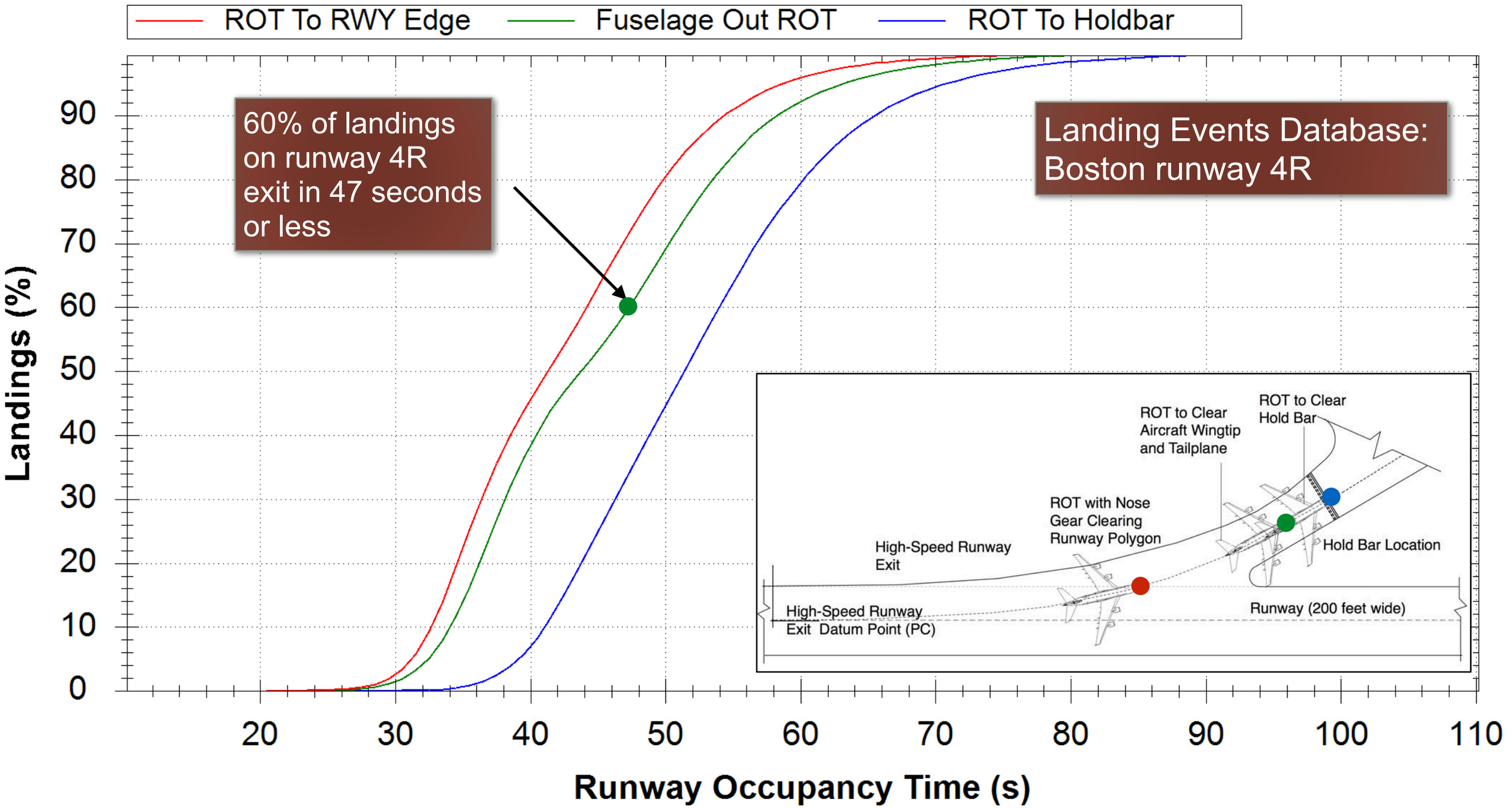
Map | Speed vs Time | Speed vs Distance | Acceleration vs Time | Acceleration vs Distance | Data

All data

Time (s)	Speed (kts)	Smoothed Speed (kts)	Distance (ft)	Acceleration (m/s^2)	Smoothed Acceleration (m/s^2)	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

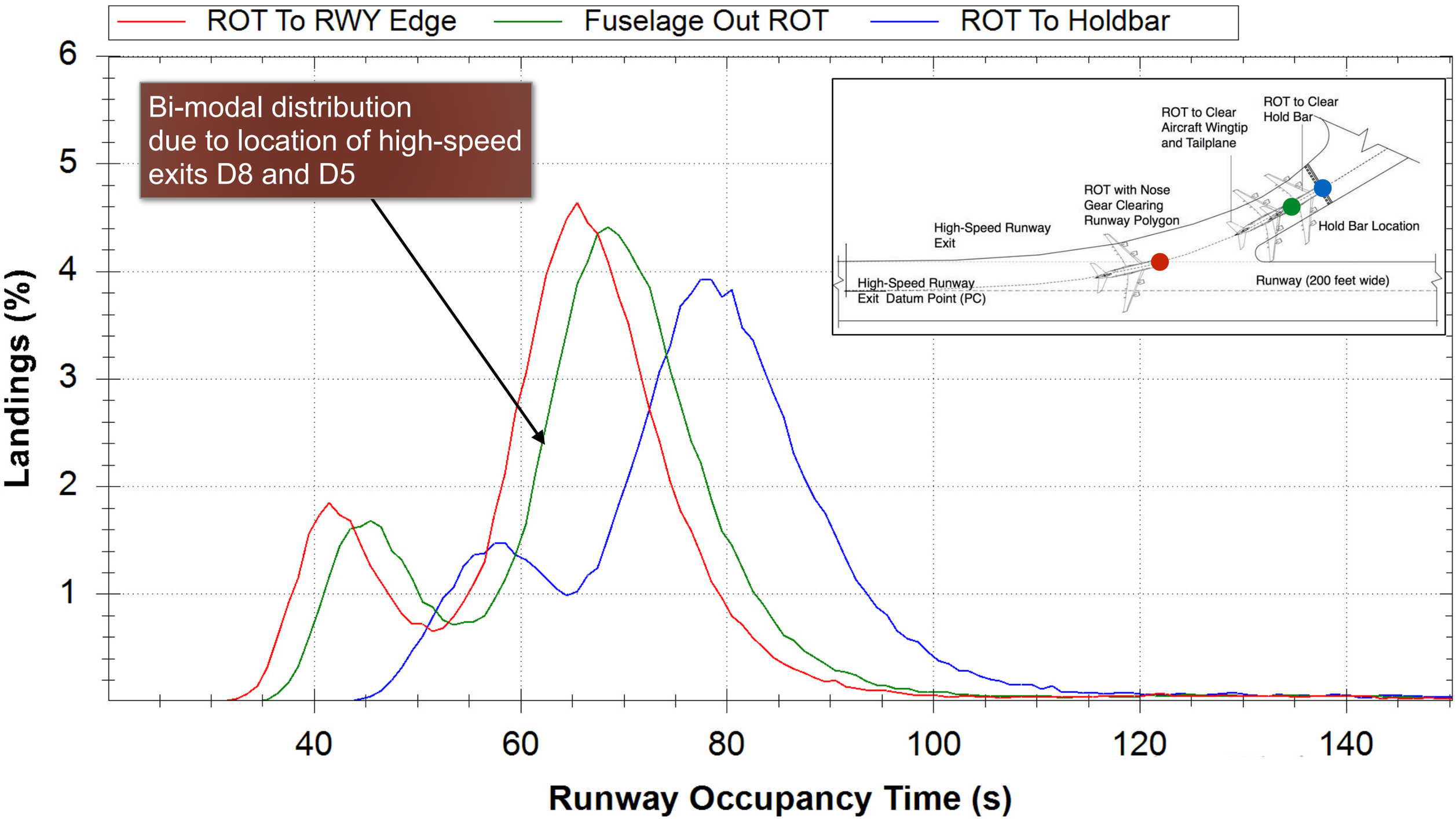
Runway Occupancy Time Information

CDF of ROT for BOS - 04R

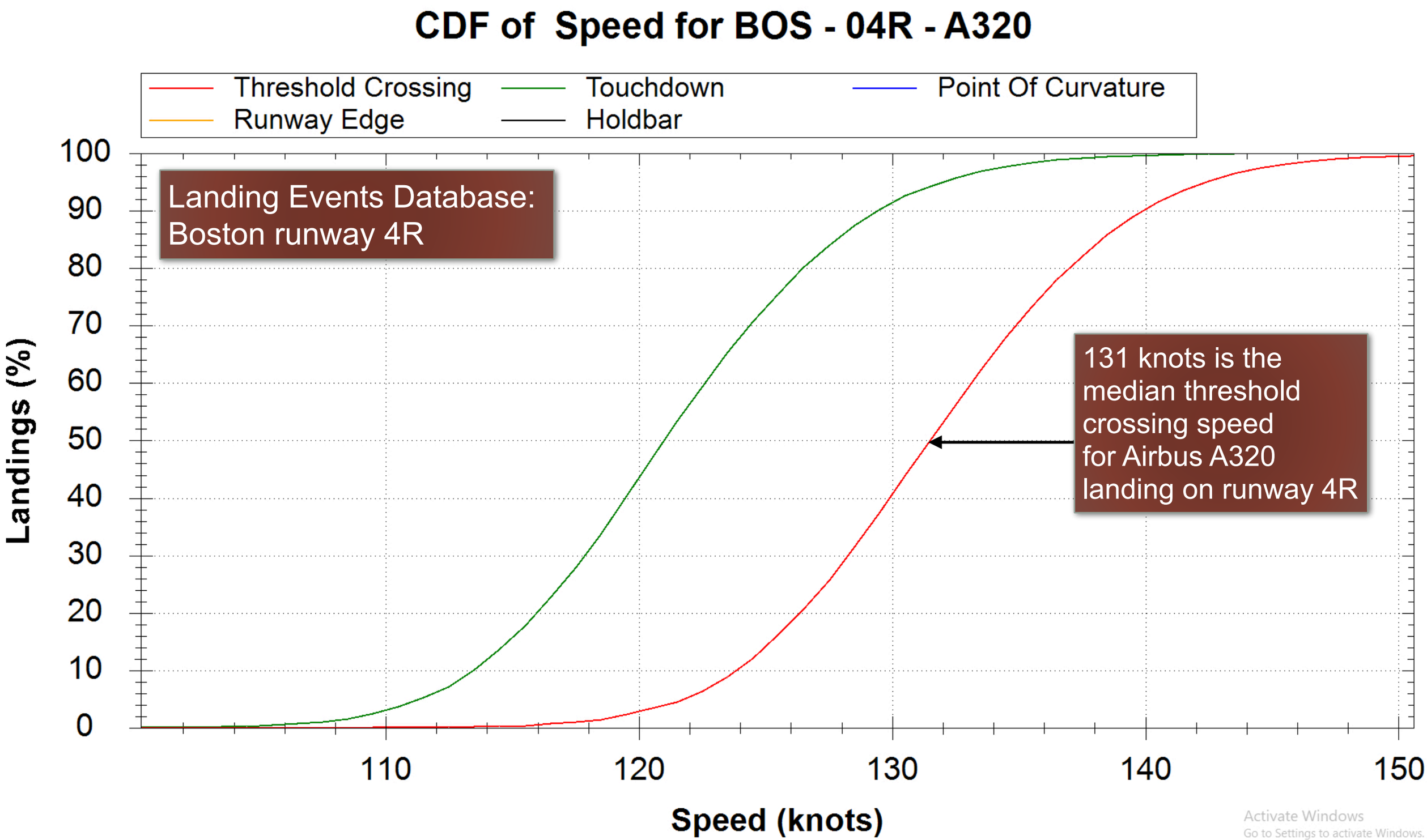


Distribution of Runway Occupancy Times

PDF of ROT for DEN - 16R



Ground Speed Distribution Over Runway Threshold



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)

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

Landing Events Database

- ATL
  - Aircraft Mix
  - Runway Occupancy Time
  - Speed
  - Nose Gear Down Location
  - Deceleration
  - Raw Data
  - Statistics
- BDL
- BOS
- BWI
- CLE
- CLT
- DCA
- DEN
- DFW
- DTW
- EWR
- FLL
- HNL
- HOU
- MKE
- MSP
- ORD
- PHL
- PHX
- PVD
- SAN
- SDF
- SEA
- SFO
- SLC
- SNA
- STL

ATL - Runway Occupancy Time (ROT) Analysis

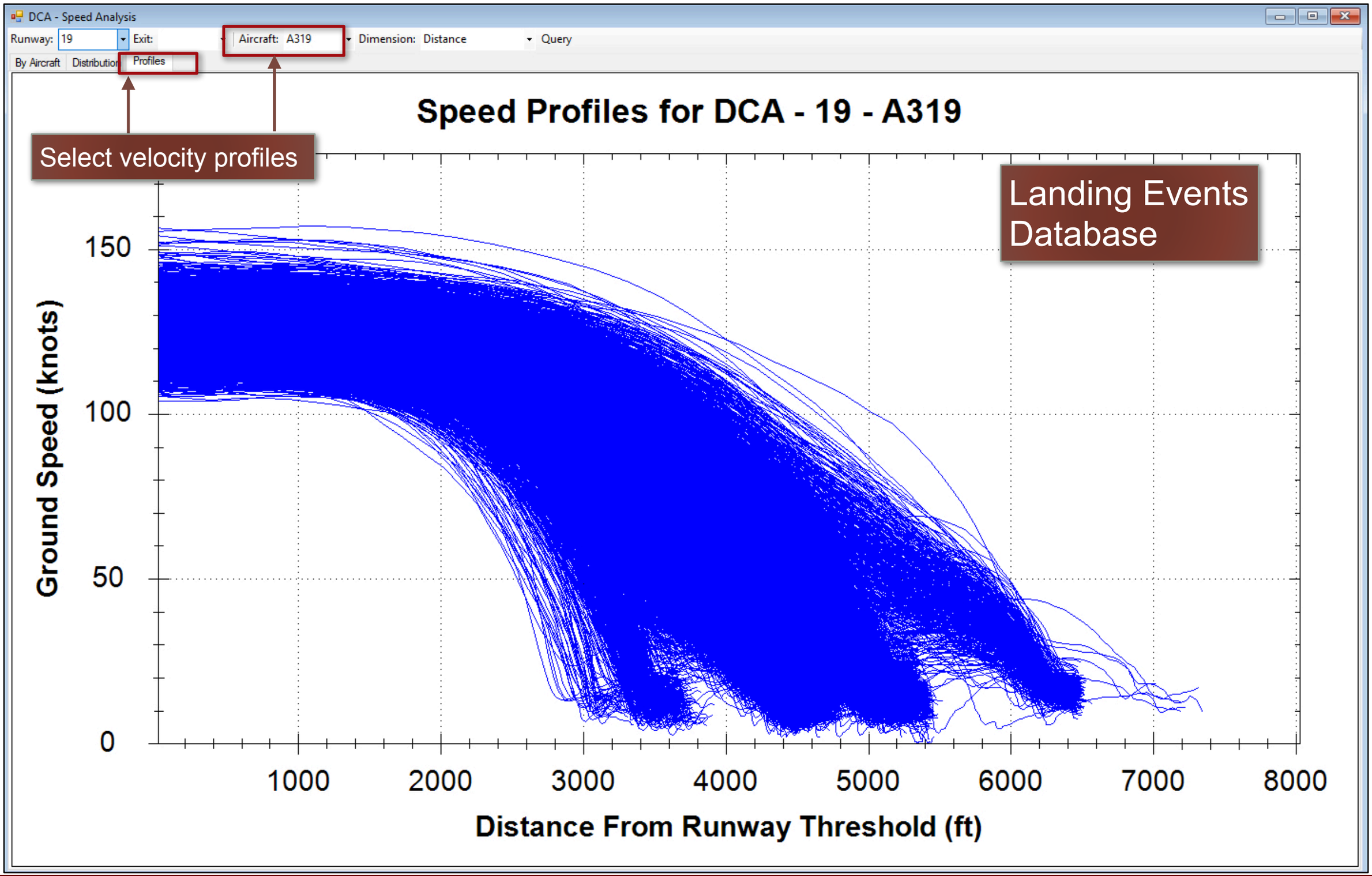
Runway: 08L | ROT Type: Fuselage Out | Query

By Aircraft | Distribution | Table

Fuselage Out ROT for ATL - 08L

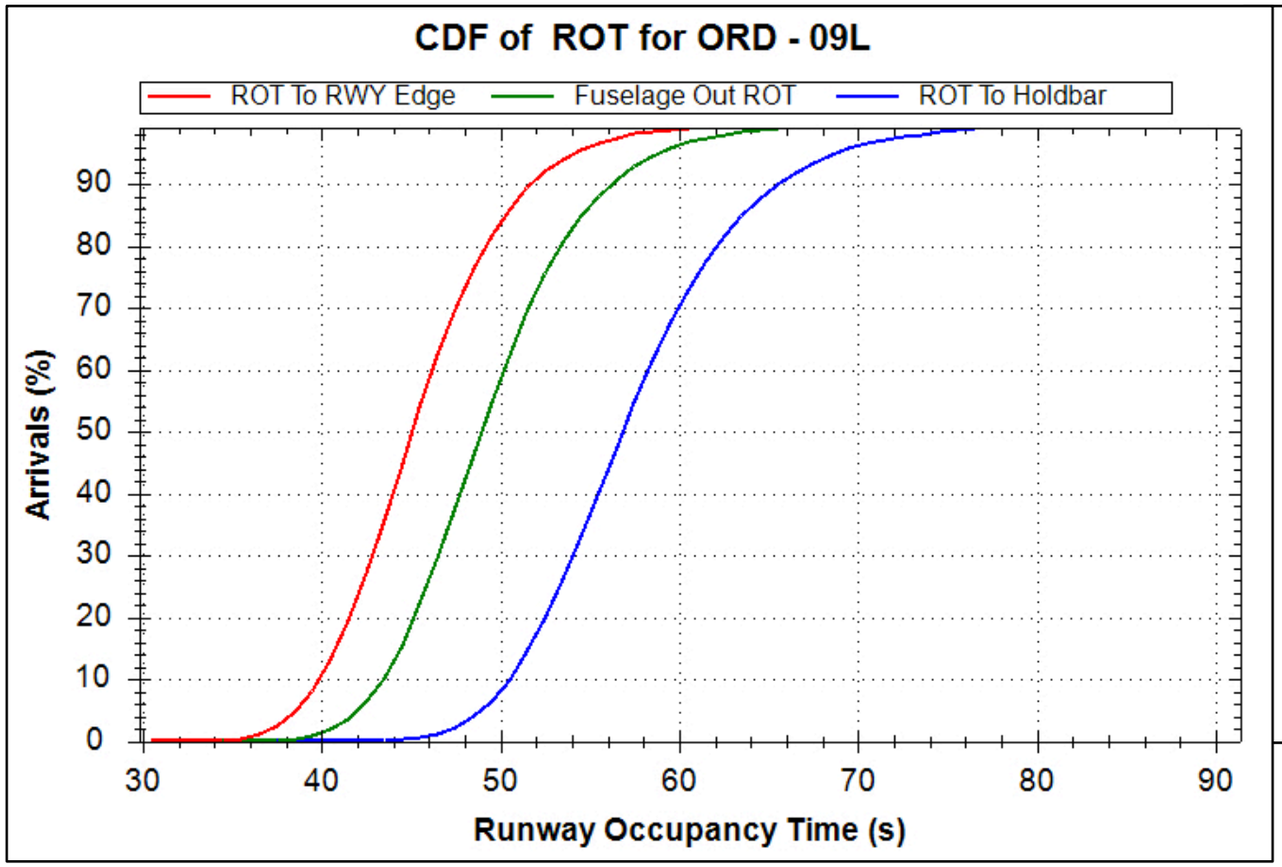
Aircraft	A	A4	A6-1	A6-2	B11	B13	B15	B5	B7	C-L	C-R	D-L	D-R	Average
A124						114.2s 100.0%								114.2s
A306	90.0s 3.0%		62.2s 33.3%	61.8s 53.3%	44.5s 0.3%					47.6s 2.0%		52.7s 8.1%		61.7s
A310			62.5s 45.5%	60.6s 34.1%						49 2.				
A319	75.6s 0.0%			59.8s 0.2%	50.5s 77.3%	71.2s 1.2%	78.7s 0.0%	36.2s 0.0%	41.3s 14.9%	47 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 10				
AC90										46 10				
AC95										59 60.0%		40.0%		
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

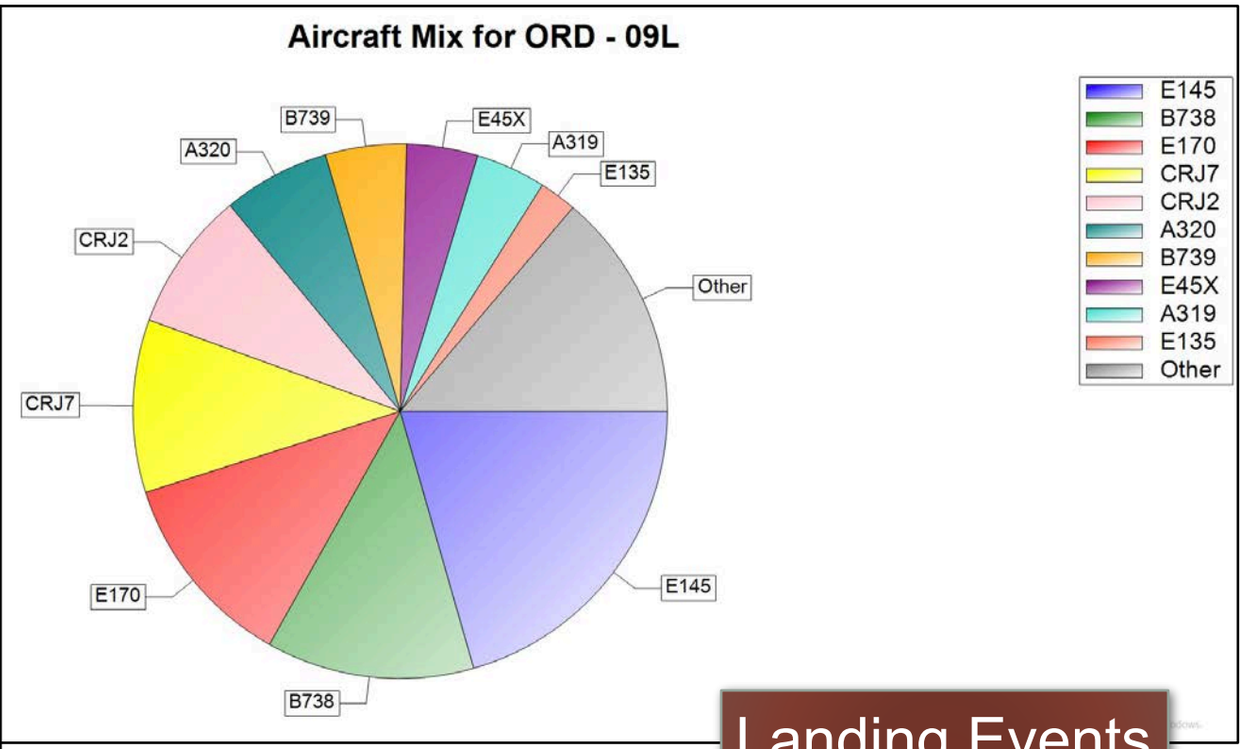
Aircraft Velocity Profiles : Airbus A319 at DCA Runway 19



ORD Airport Runway 9L (Two Usable Exits)

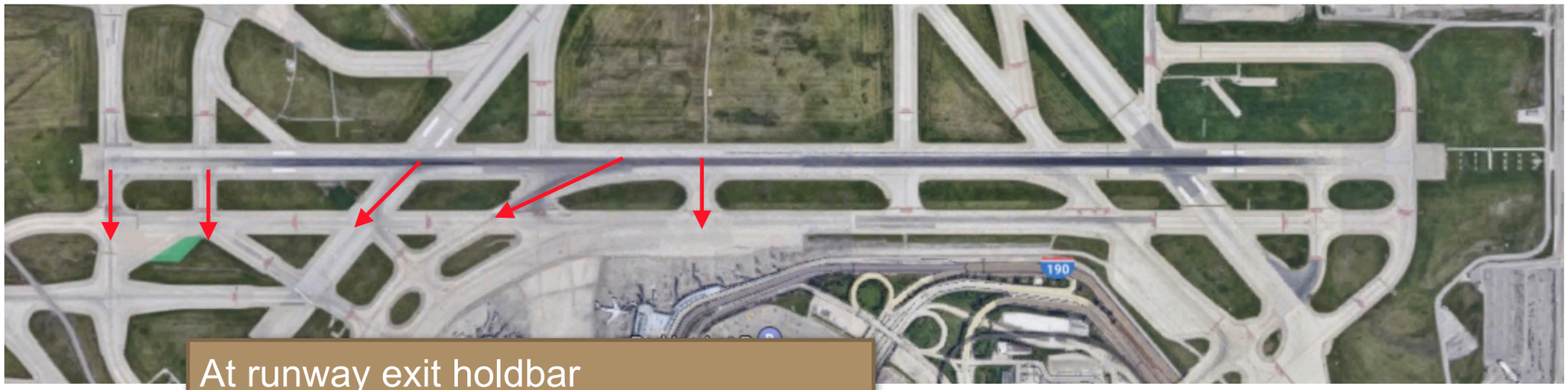
At runway **exit holdbar**
50th percentile ROT is 56 seconds
95th percentile ROT is 71 seconds
Relatively high ROT value due to few runway exits



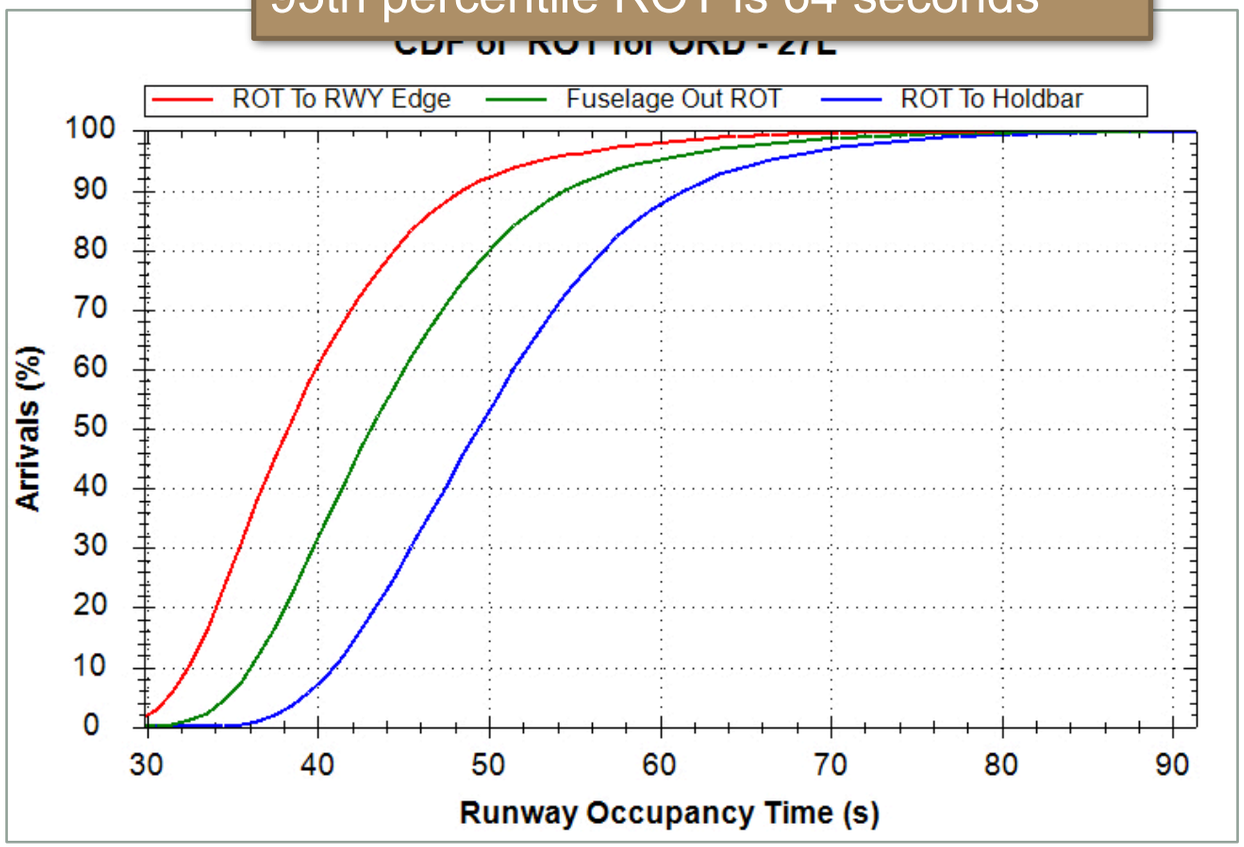


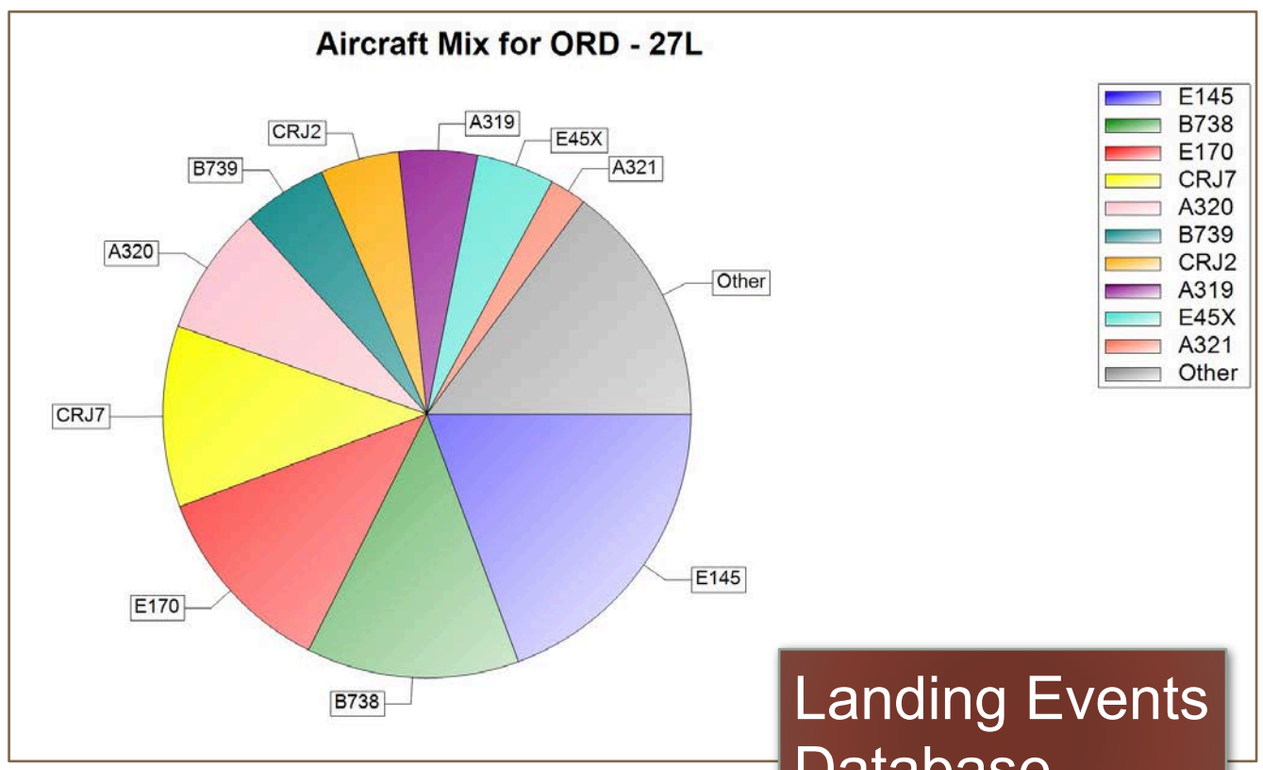
Landing Events Database

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

The Runway Exit Design Tool can be downloaded at:

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

New version REDIM 4.0

REDIM

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

Virginia Tech - Air Transportation Systems Lab

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Nicolas Hinze (Team Co-Leader)
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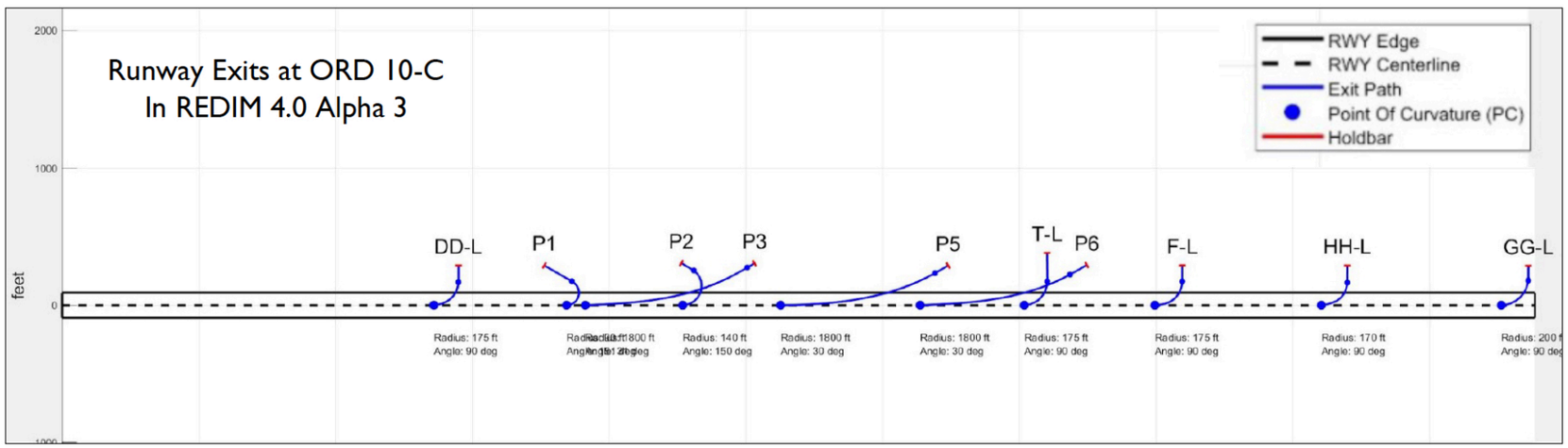
Mihir Rimjha
Arman Izadi

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 length to reduce bias** observed in some runway clusters
- Improvements to runway exit logic and runway exit definition (runway exit libraries)



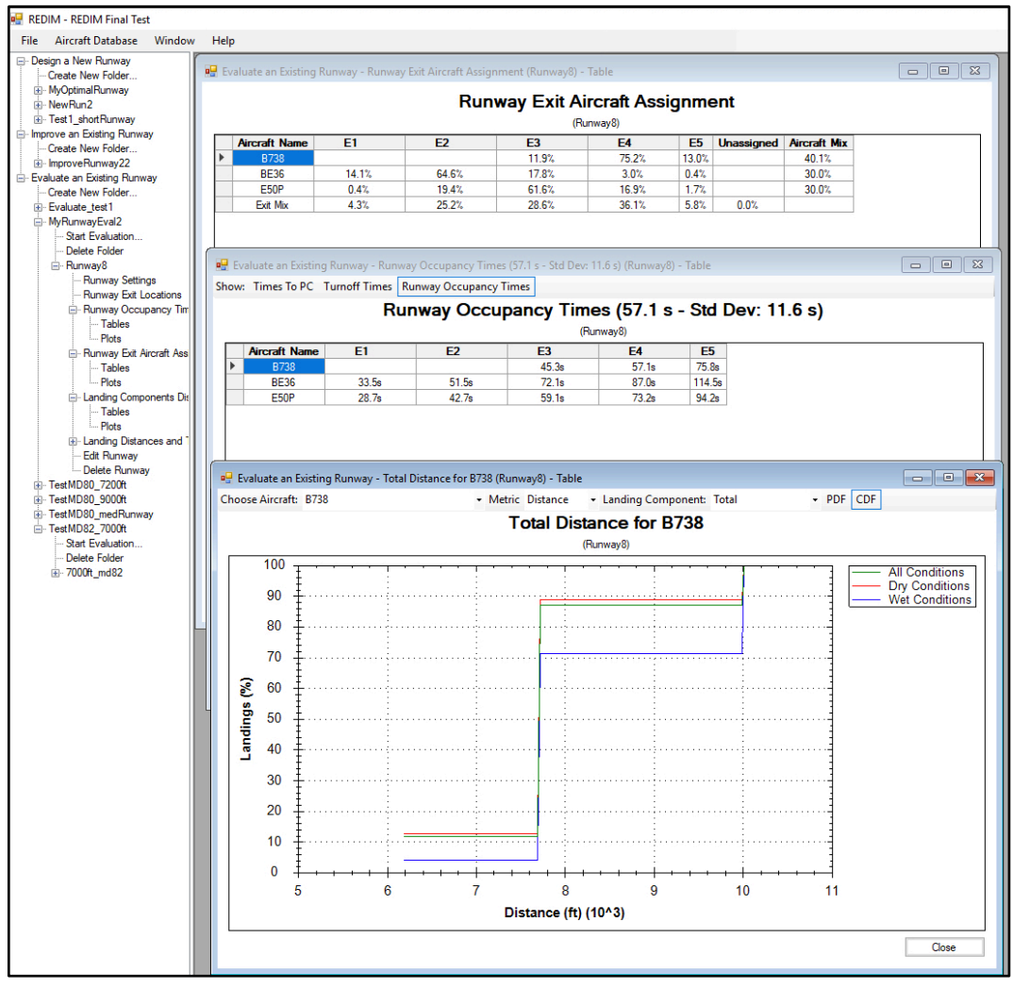
General Information About the Model

- 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

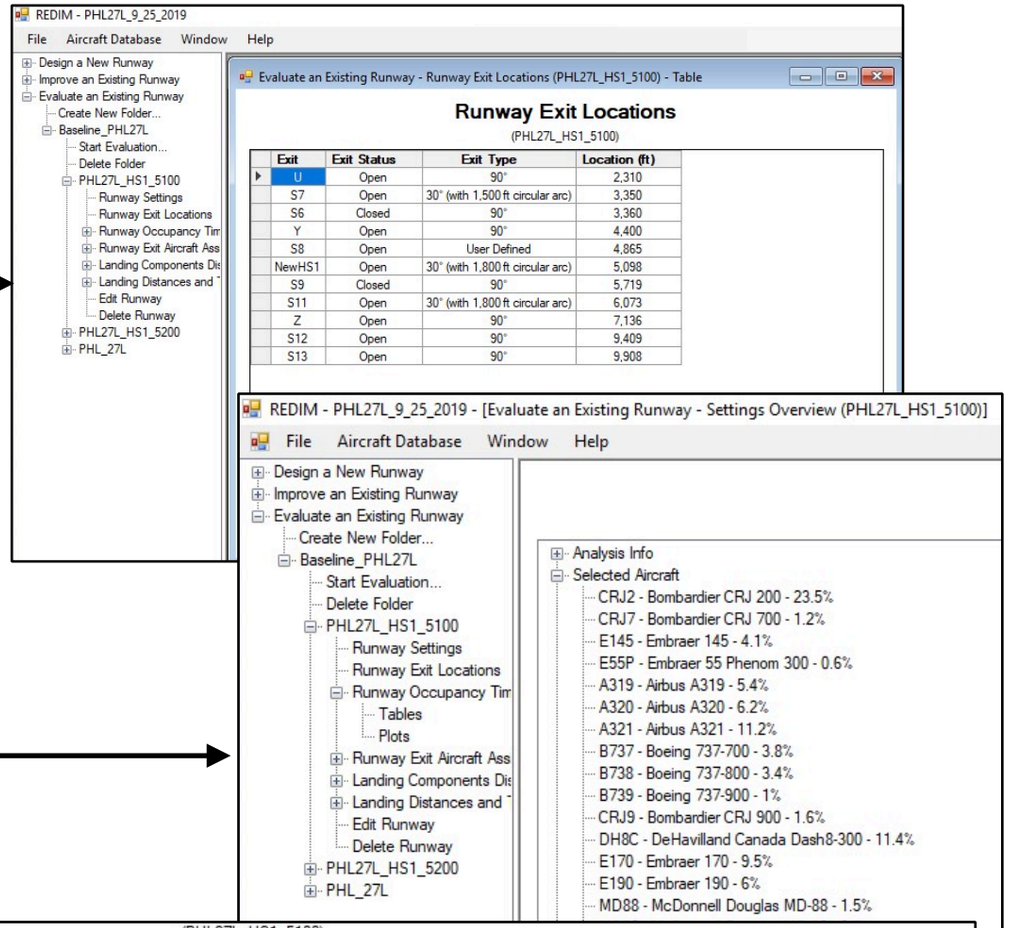


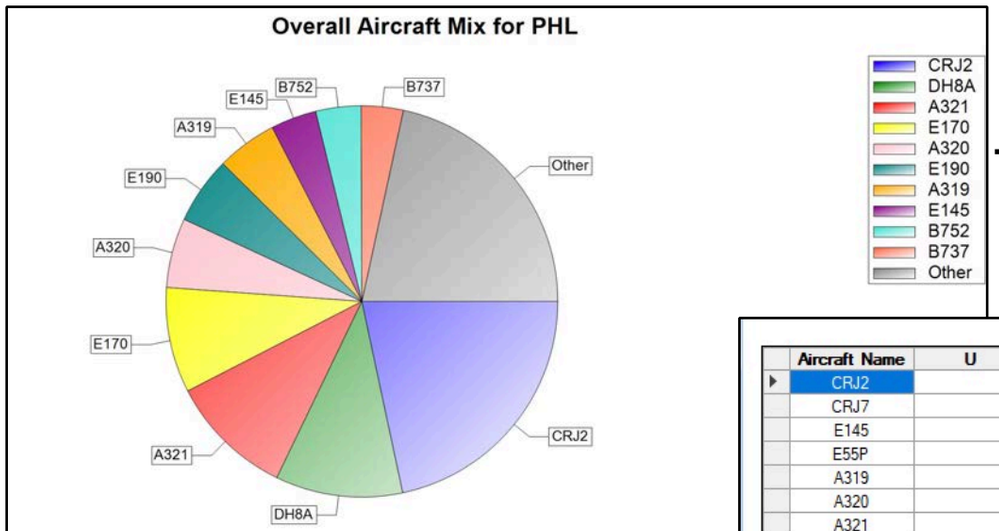
Model uses Monte Carlo Simulation to predict aircraft landing roll performance

- 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





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								49.6s	57.1s
B738								47.3s	53.0s
B739								47.1s	53.5s
CRJ9		28.0s						47.7s	55.9s
DH8C		34.6s						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
Aircraft Mix	Provides an overview of aircraft fleet mix	Percent of aircraft types simulated in the analysis
Runway Occupancy Time	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)
Runway Exit Utilization	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
Aircraft Landing Performance	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

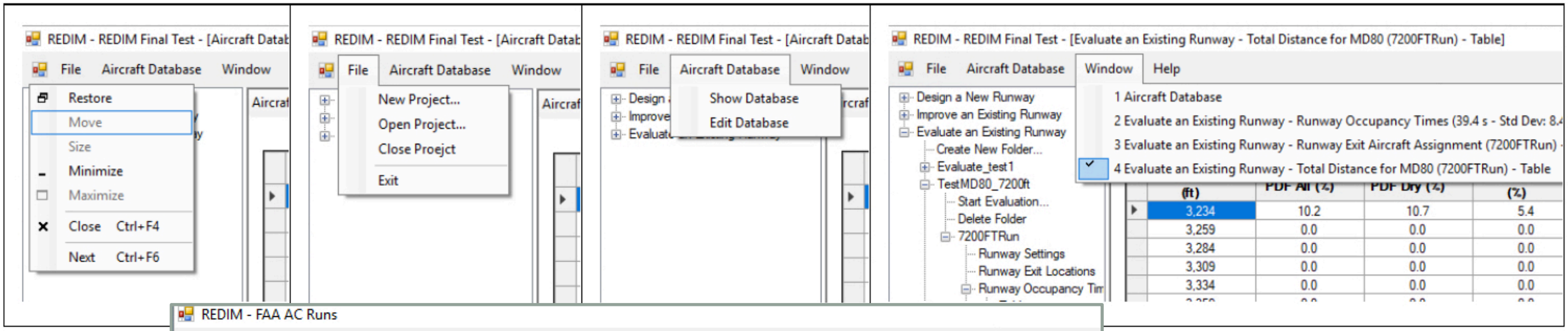
- REDIM 4.0 contains data for 320 aircraft
  - 150 turbofan aircraft
  - 110 piston aircraft
  - 60 turboprop aircraft

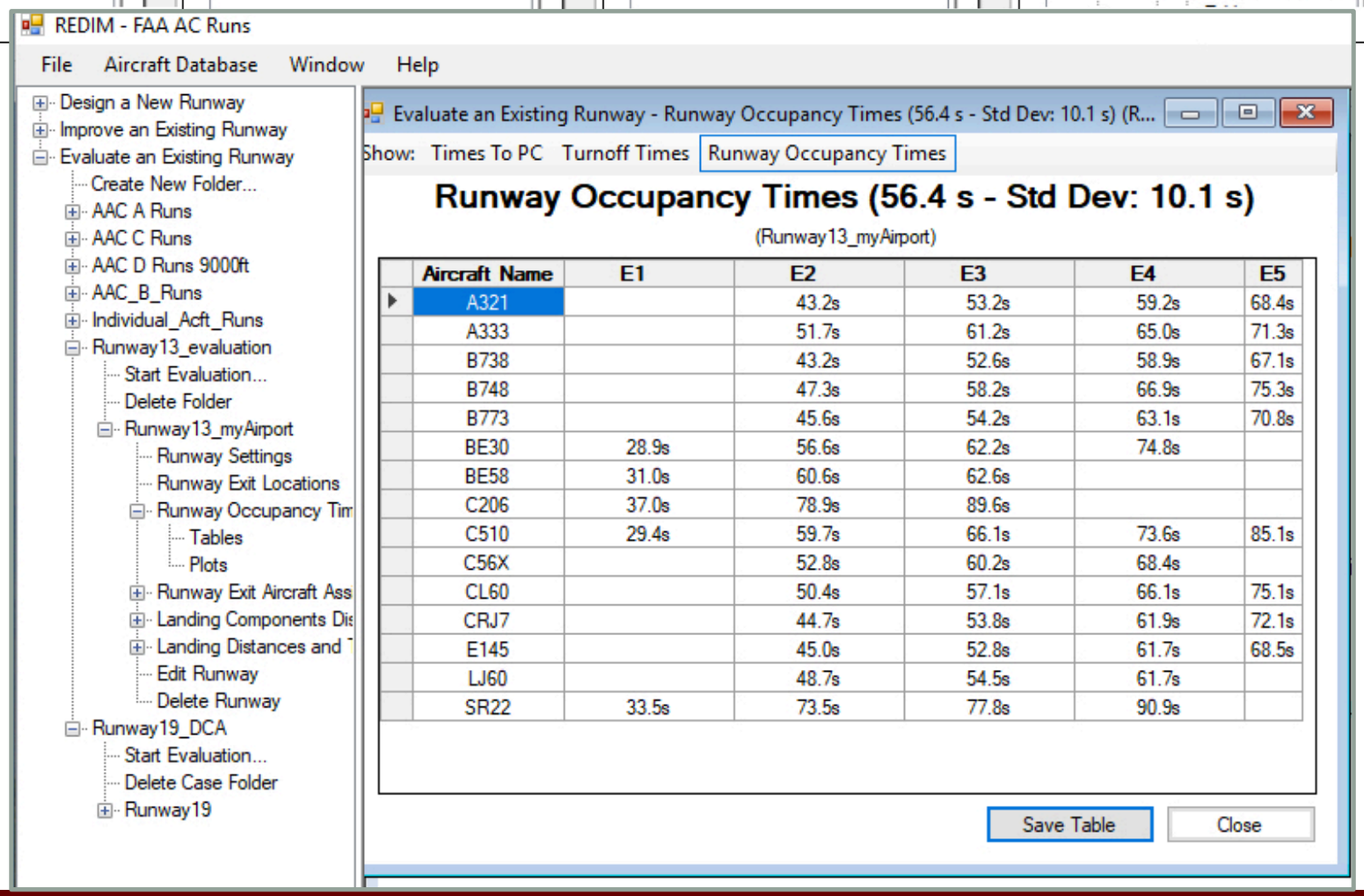
Aircraft Design Group (ADG): III

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





Sample Screens of Runway Exit Design Tool

REDIM - REDIM Final Test

File Aircraft Database Window Help

- Design a New Runway
  - Create New Folder...
  - MyOptimalRunway
  - NewRun2
  - Test1_shortRunway
- Improve an Existing Runway
  - Create New Folder...
  - ImproveRunway22
- Evaluate an Existing Runway
  - Create New Folder...
  - Evaluate_test1
  - MyRunwayEval2
    - Start Evaluation...
    - Delete Folder
    - Runway8
      - Runway Settings
      - Runway Exit Locations
      - Runway Occupancy Tim
        - Tables
        - Plots
      - Runway Exit Aircraft Ass
        - Tables
        - Plots
      - Landing Components Dis
        - Tables
        - Plots
      - Landing Distances and T
      - Edit Runway
      - Delete Runway
  - TestMD80_7200ft
  - TestMD80_9000ft
  - TestMD80_medRunway
  - TestMD82_7000ft
    - Start Evaluation...
    - Delete Folder
    - 7000ft_md82

Evaluate an Existing Runway - Runway Exit Aircraft Assignment (Runway8) - Table

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%	

Evaluate an Existing Runway - Runway Occupancy Times (57.1 s - Std Dev: 11.6 s) (Runway8) - Table

Show: Times To PC Turnoff Times Runway Occupancy Times

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

(Runway8)

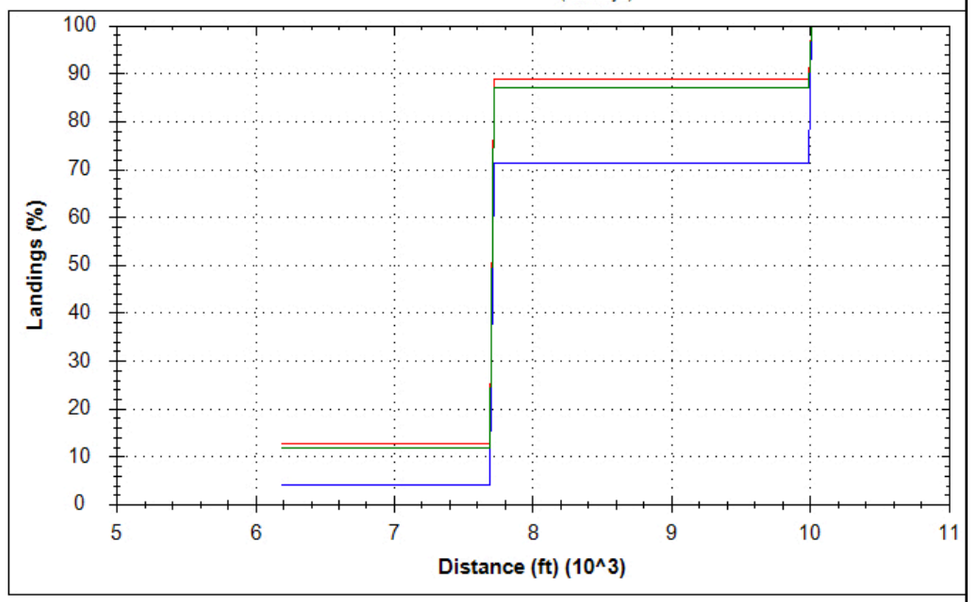
Aircraft Name	E1	E2	E3	E4	E5
B738			45.3s	57.1s	75.8s
BE36	33.5s	51.5s	72.1s	87.0s	114.5s
E50P	28.7s	42.7s	59.1s	73.2s	94.2s

Evaluate an Existing Runway - Total Distance for B738 (Runway8) - Table

Choose Aircraft: B738 Metric Distance Landing Component: Total PDI

Total Distance for B738

(Runway8)



REDIM - REDIM Final Test

File Aircraft Database Window Help

- Design a New Runway
  - Create New Folder...
  - MyOptimalRunway
  - NewRun2
  - Test1_shortRunway
- Improve an Existing Runway
  - Create New Folder...
  - ImproveRunway22
- Evaluate an Existing Runway
  - Create New Folder...
  - Evaluate_test1
  - MyRunwayEval2
    - Start Evaluation...
    - Delete Folder
    - Runway8
      - Runway Settings

Evaluate an Existing Runway - Runway Exit Locations (Runway8) - Table

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

Save Table Close

REDIM - REDIM Final Test

File Aircraft Database Window Help

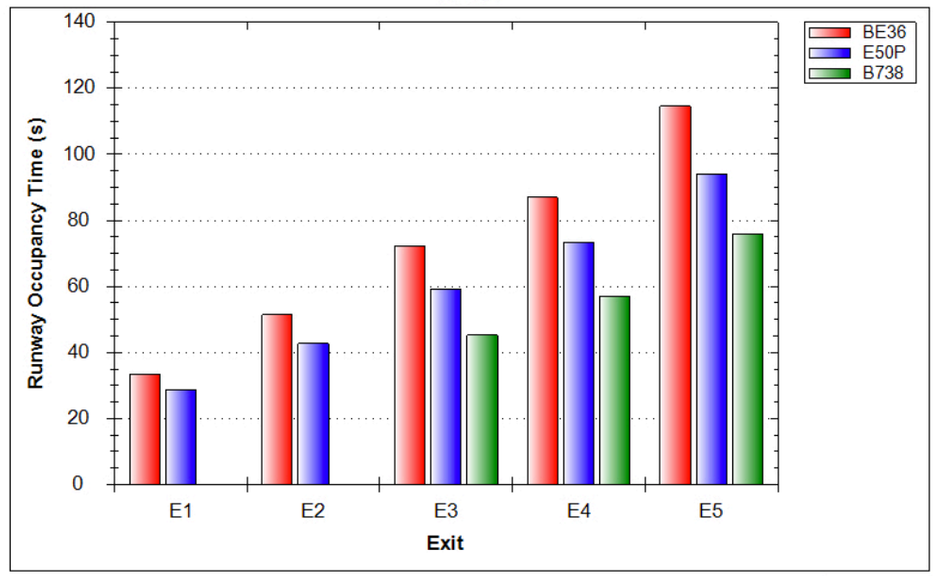
- Design a New Runway
  - Create New Folder...
  - MyOptimalRunway
  - NewRun2
  - Test1_shortRunway
- Improve an Existing Runway
  - Create New Folder...
  - ImproveRunway22
- Evaluate an Existing Runway
  - Create New Folder...
  - Evaluate_test1
  - MyRunwayEval2
    - Start Evaluation...
    - Delete Folder
    - Runway8
      - Runway Settings
      - Runway Exit Locations
      - Runway Occupancy Tim
        - Tables
        - Plots
      - Runway Exit Aircraft Ass
        - Tables
        - Plots
      - Landing Components Dis
        - Tables
        - Plots
      - Landing Distances and T
      - Edit Runway
      - Delete Runway
  - TestMD80_7200ft
  - TestMD80_9000ft
  - TestMD80_medRunway
  - TestMD82_7000ft
    - Start Evaluation...
    - Delete Folder
    - 7000ft_md82

Evaluate an Existing Runway - Runway Occupancy Times (57.1 s - Std Dev: 11.6 s) (Runway8) - Table

Show: Times To PC Turnoff Times Runway Occupancy Times

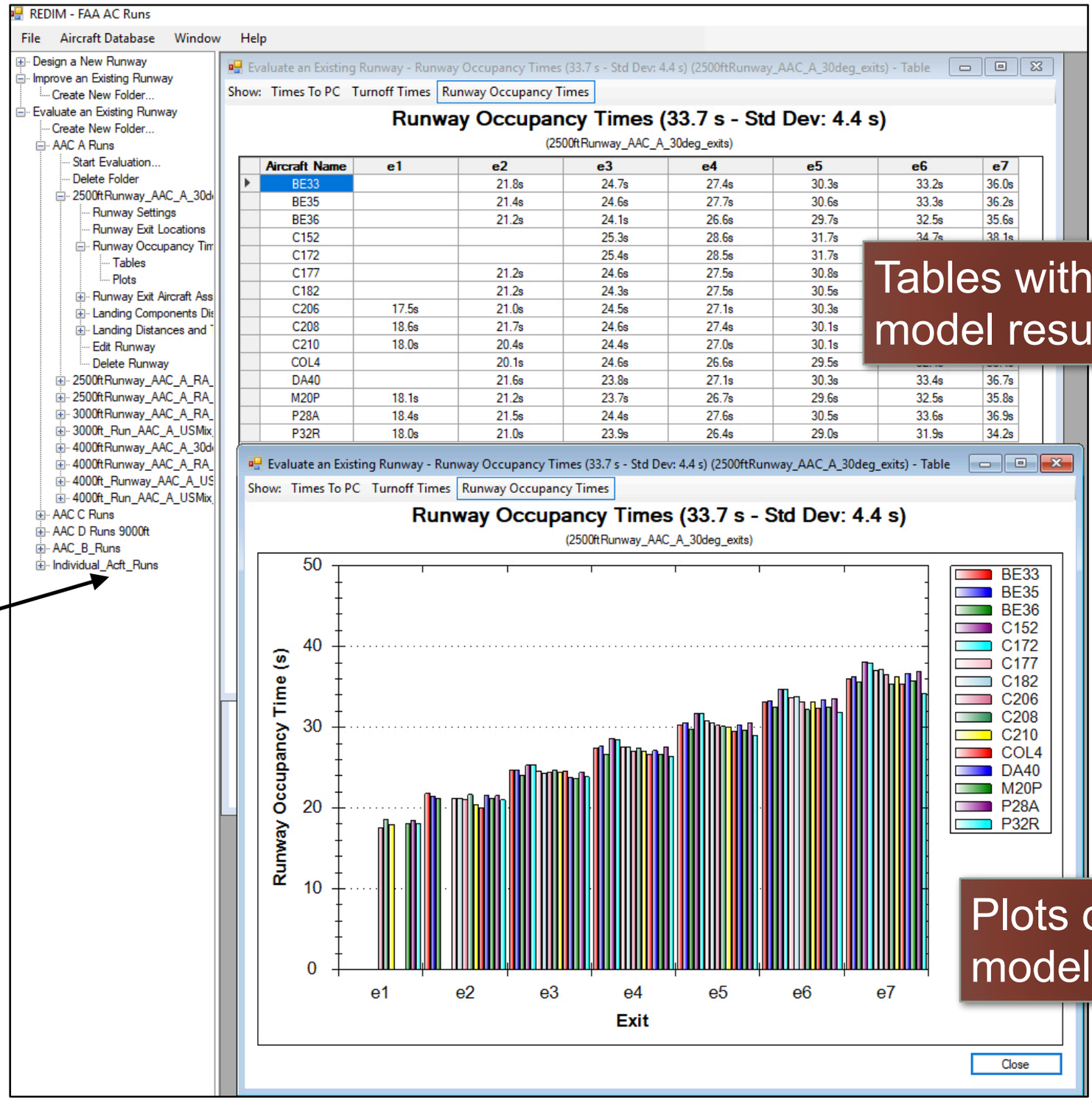
Runway Occupancy Times (57.1 s - Std Dev: 11.6 s)

(Runway8)



Close

Interface and Panels in the Runway Exit Design Model

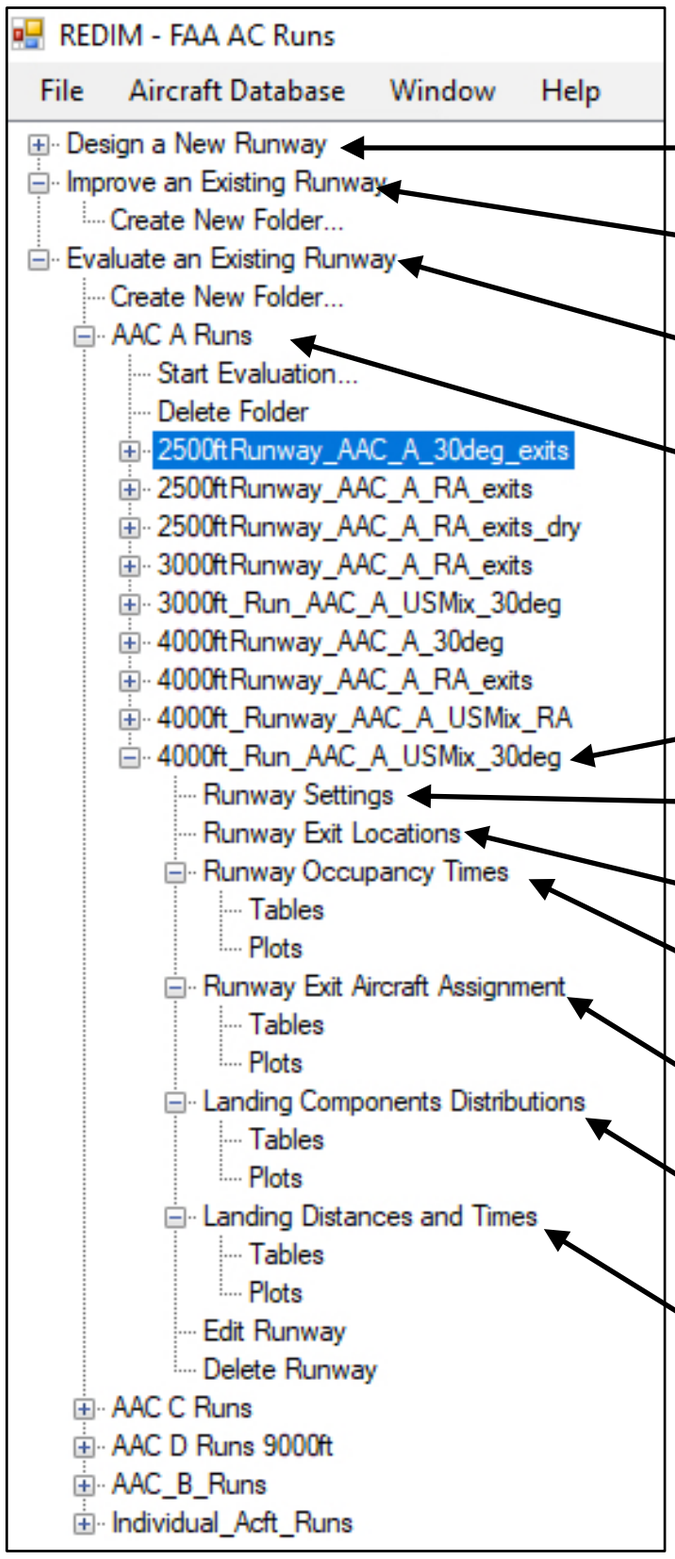


Tables with relevant model results

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

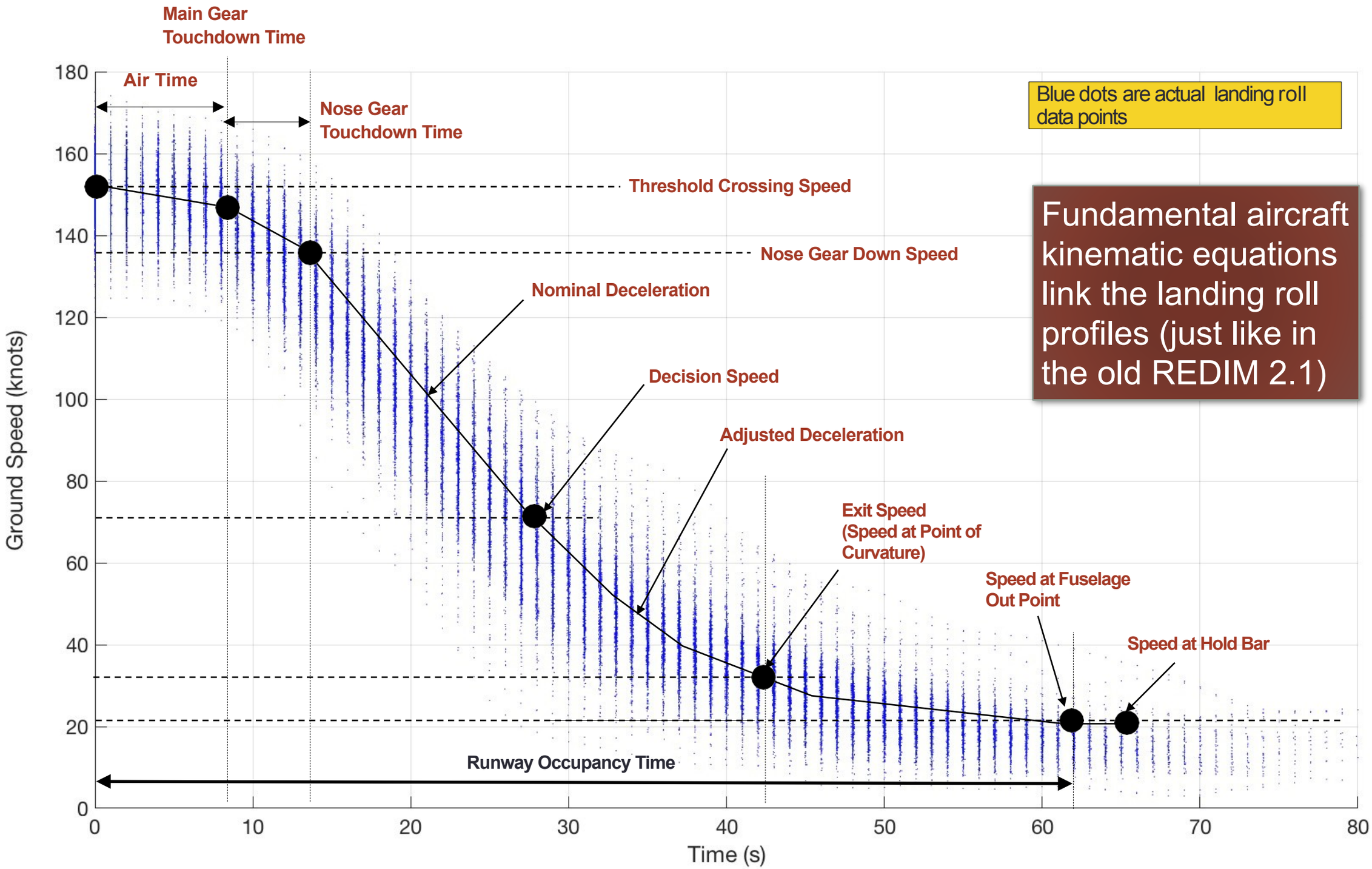
Runway occupancy times (tables and plots)

Runway exit assignment (tables and plots)

Aircraft landing distributions (tables and plots)

Aircraft landing distances and times (tables and plots)

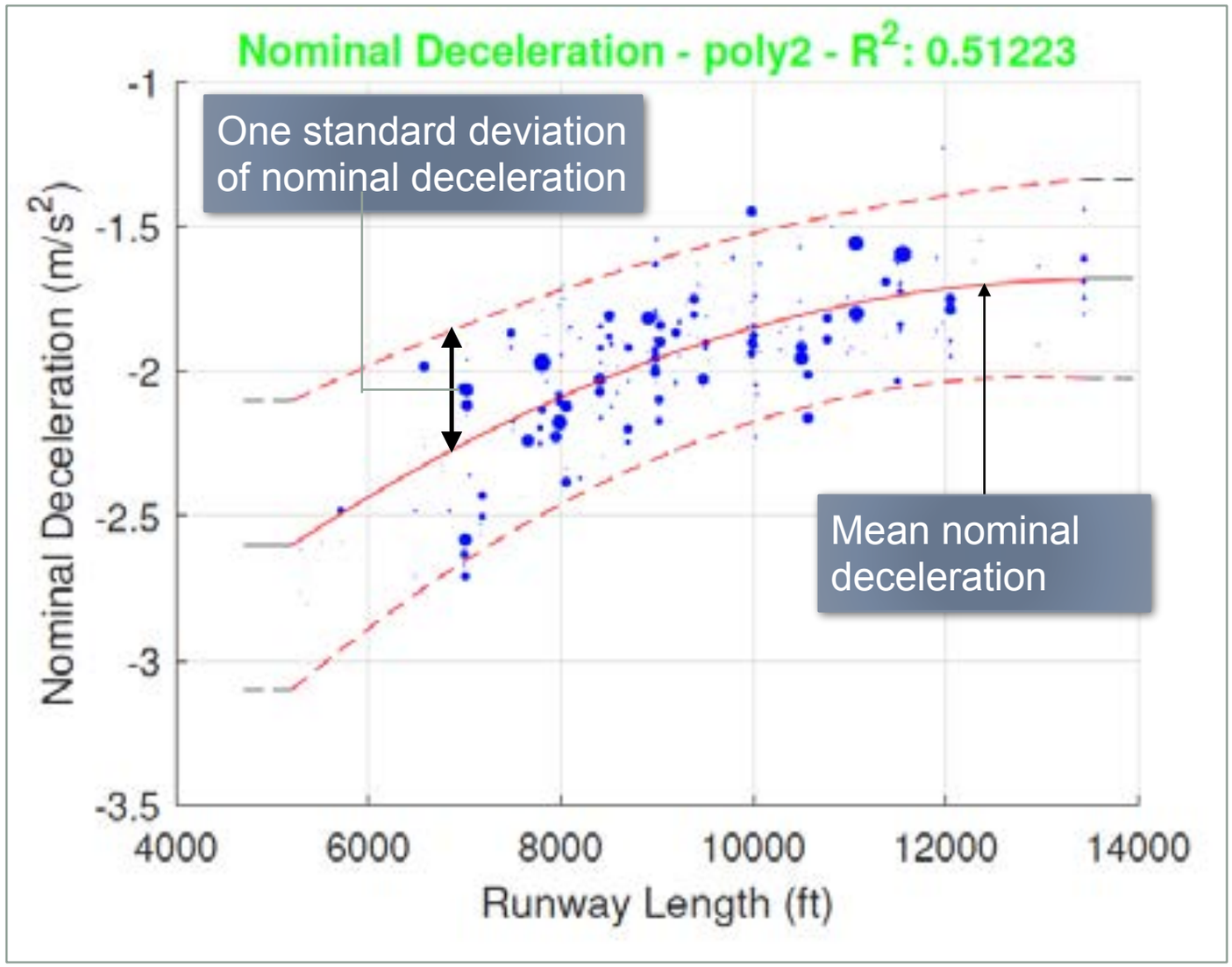
Runway Exit Model Landing Roll Profile Phases Modeled



Fundamental aircraft kinematic equations link the landing roll profiles (just like in the old REDIM 2.1)

REDIM 4 Individual Aircraft Deceleration Model

Airbus A320 Data

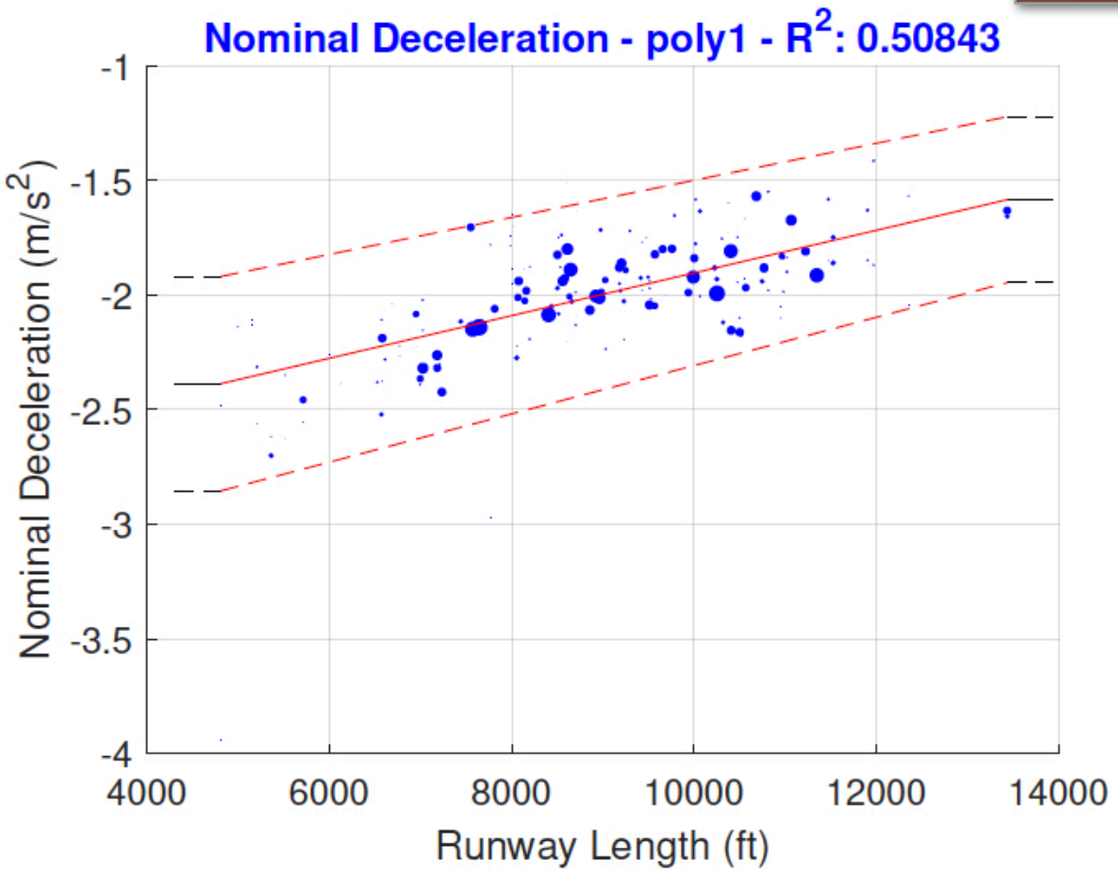


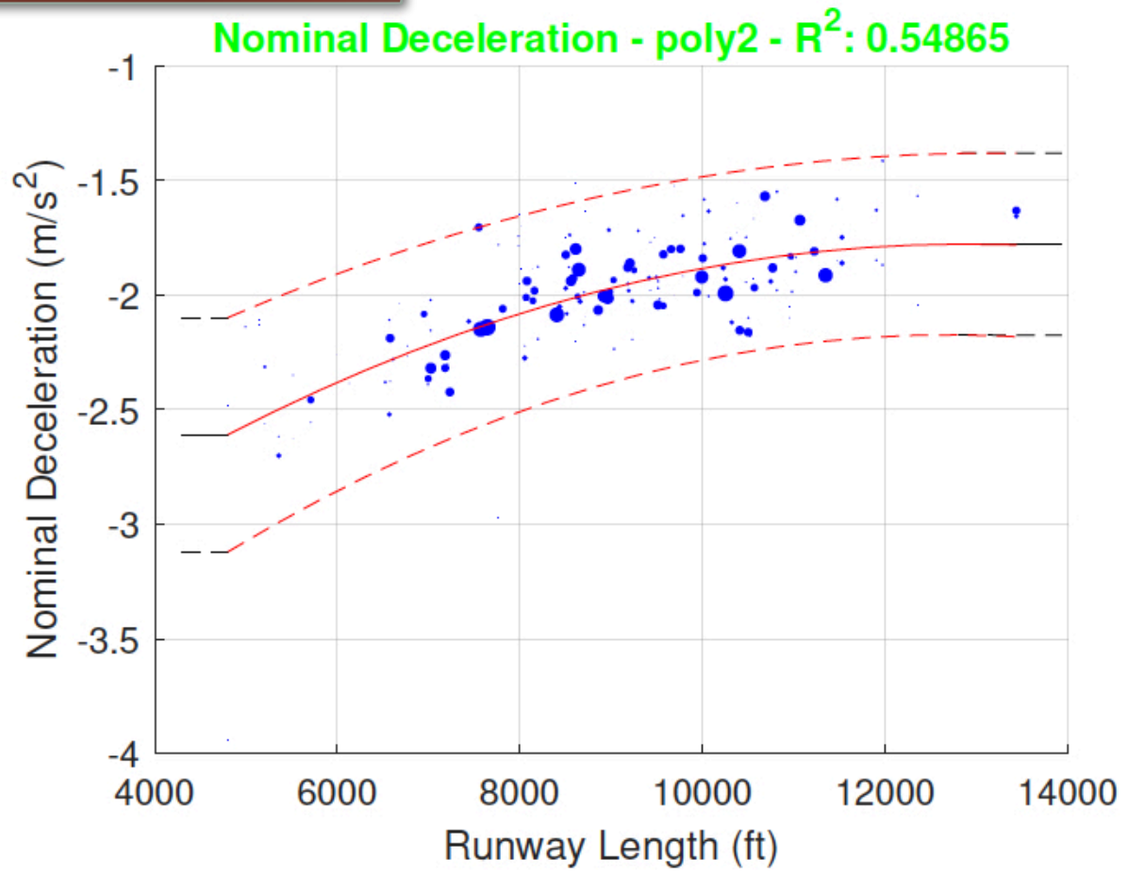
- Model selects the best polynomial fit of nominal deceleration as a function of runway length
- Deceleration data is monotonic
- Each dot is a runway end of data collected at 43 airports
- Each dot is weighted by the number of operations at every airport

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)

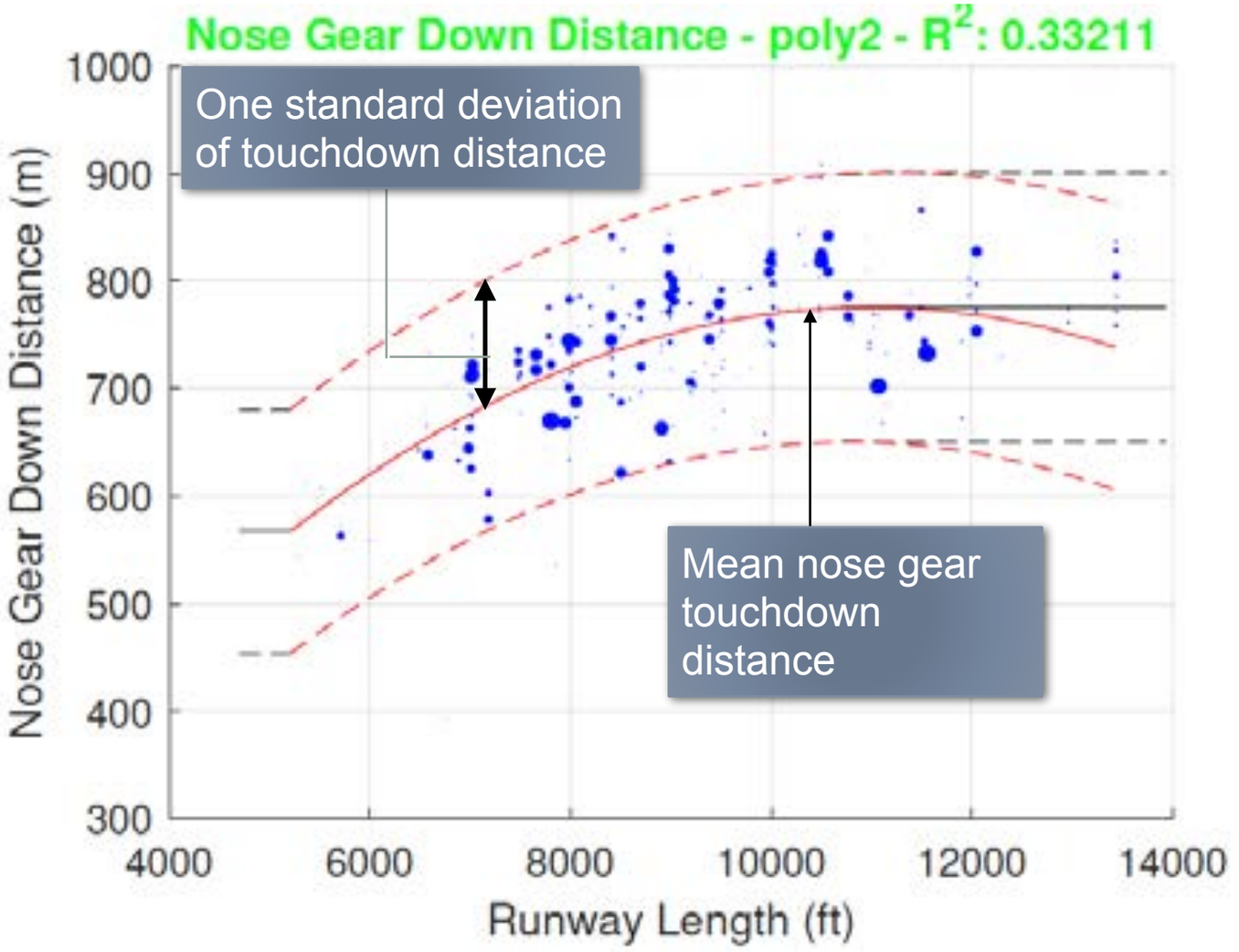
AAC Group C Model





REDIM 4 Individual Aircraft Touchdown Model

Airbus A320 Data

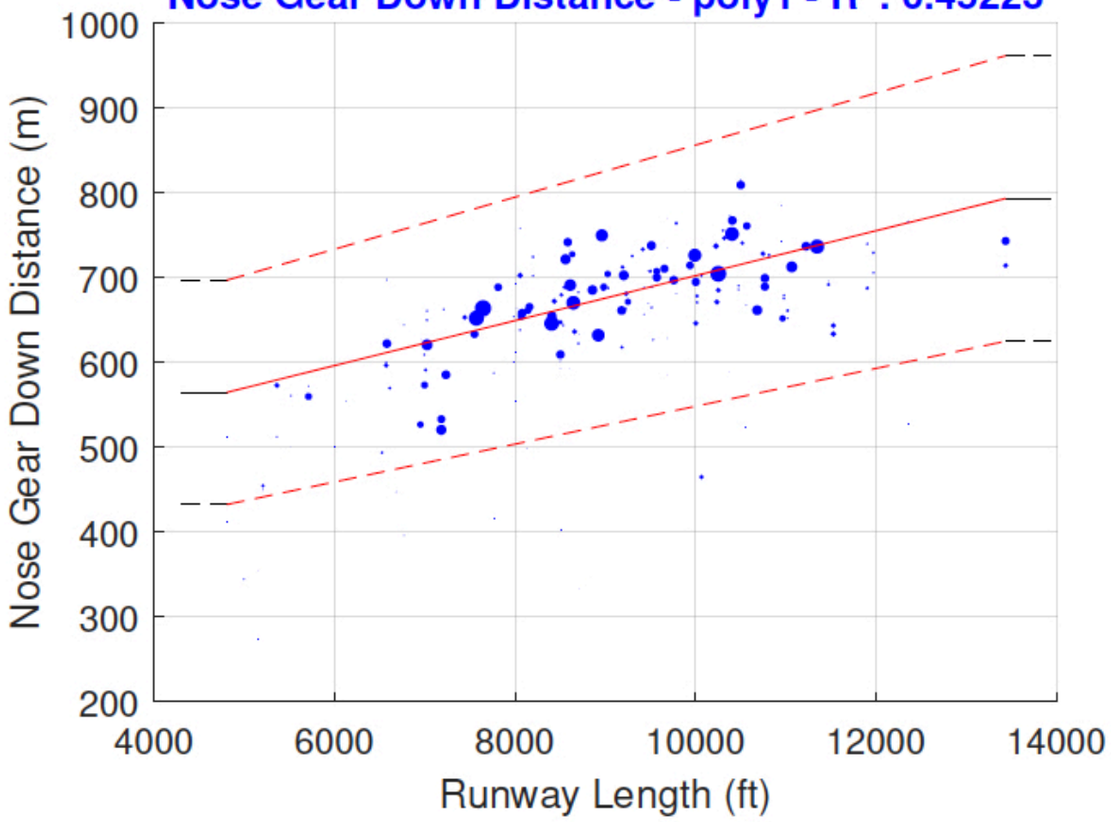


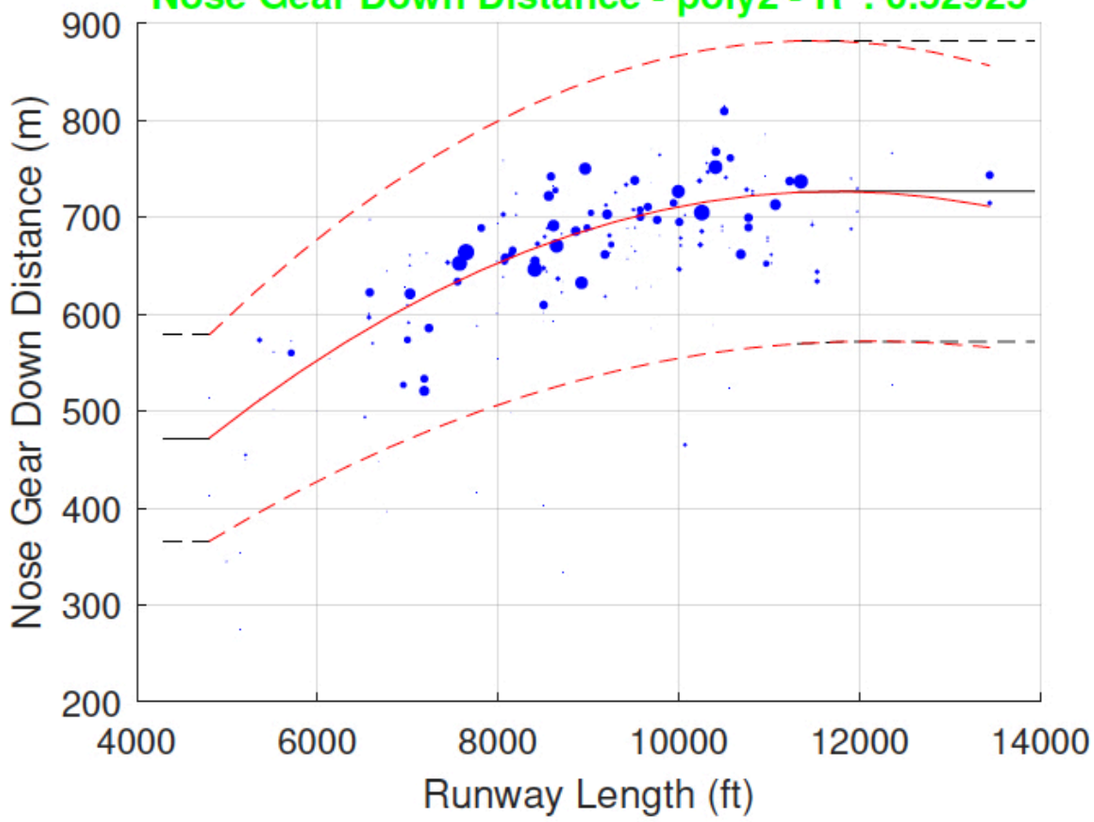
- Model selects the best polynomial fit of the touchdown location as a function of runway length
- Touchdown data is monotonic
- Each dot is a runway end of data collected at 43 airports
- Each dot is weighted by the number of operations at every airport

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

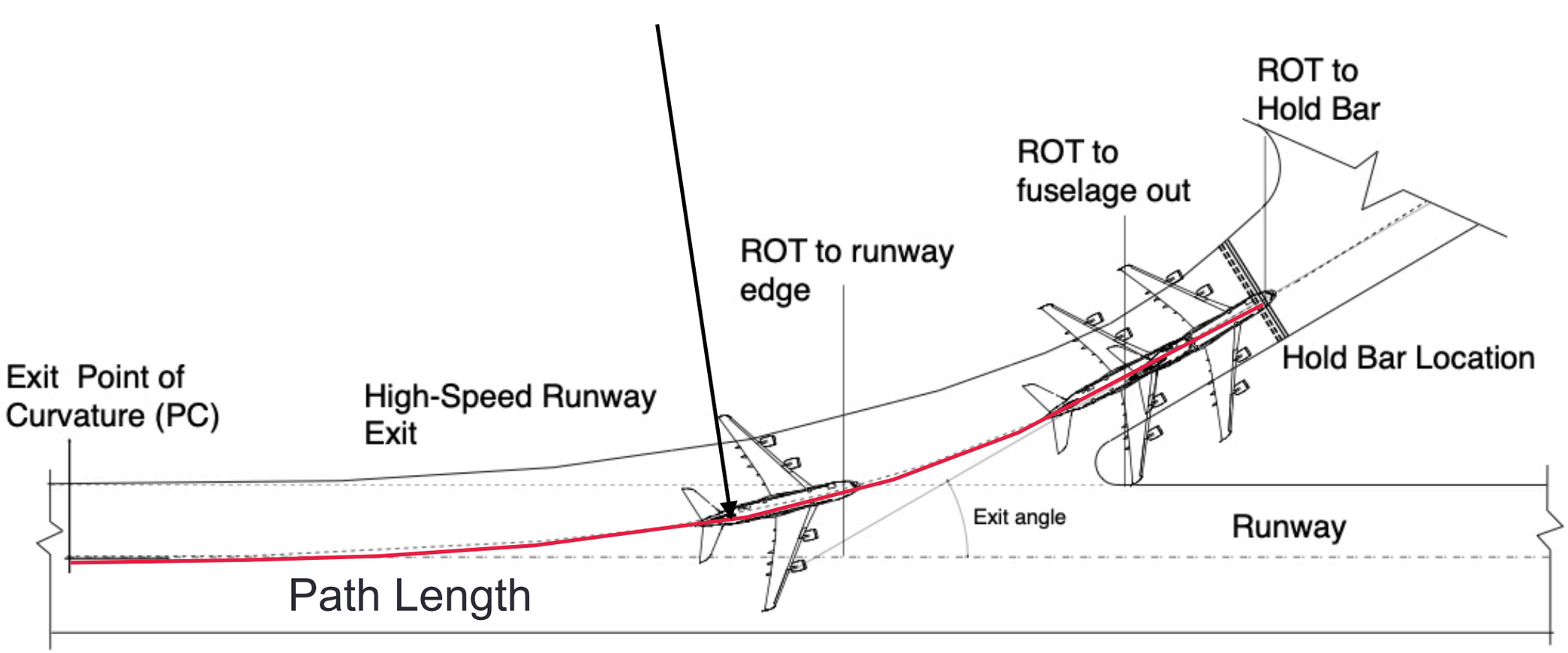




Runway Exit Clusters and Geometry

- 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



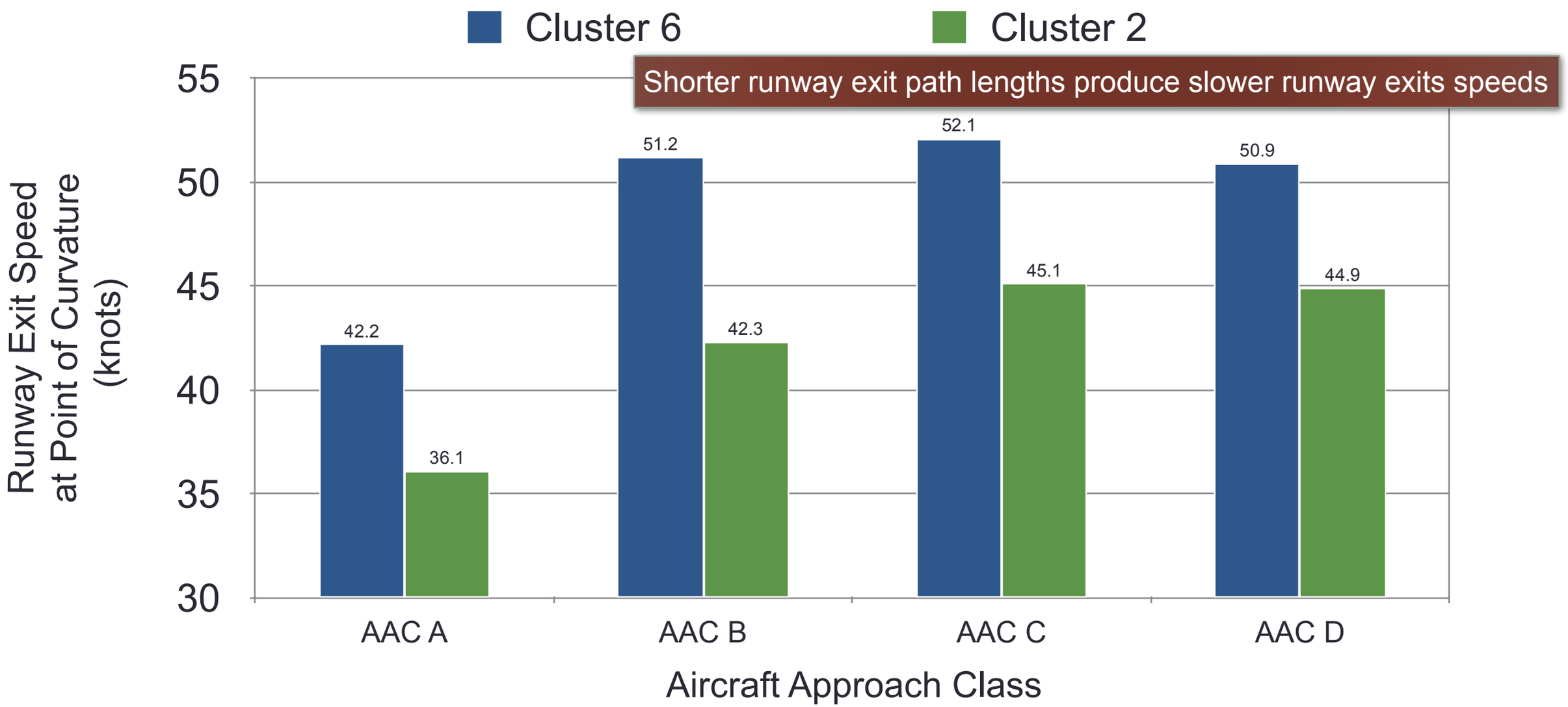
Runway Exit Clusters in REDIM 3 and 4

	Angle (deg)		Radius (ft)		Path Length (ft)		Number Of Exits	Type of Runway
Cluster #	Min	Max	Min	Max	Min	Max		Exit
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

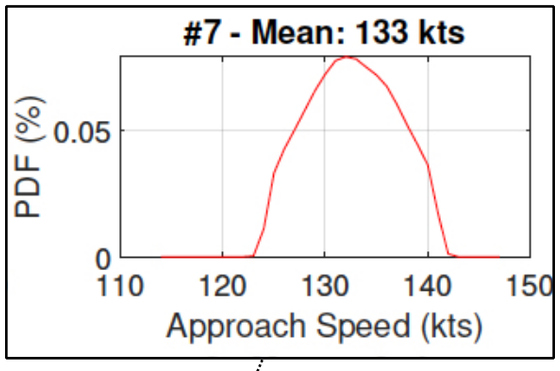
Model uses 20 runway exit clusters to differentiate runway exit characteristics

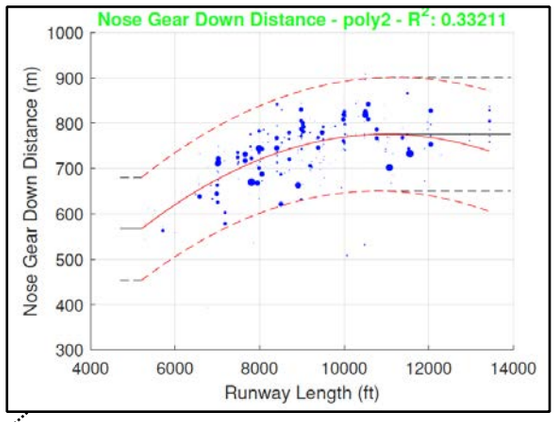
Effect of Runway Exit Cluster on Exit Speed

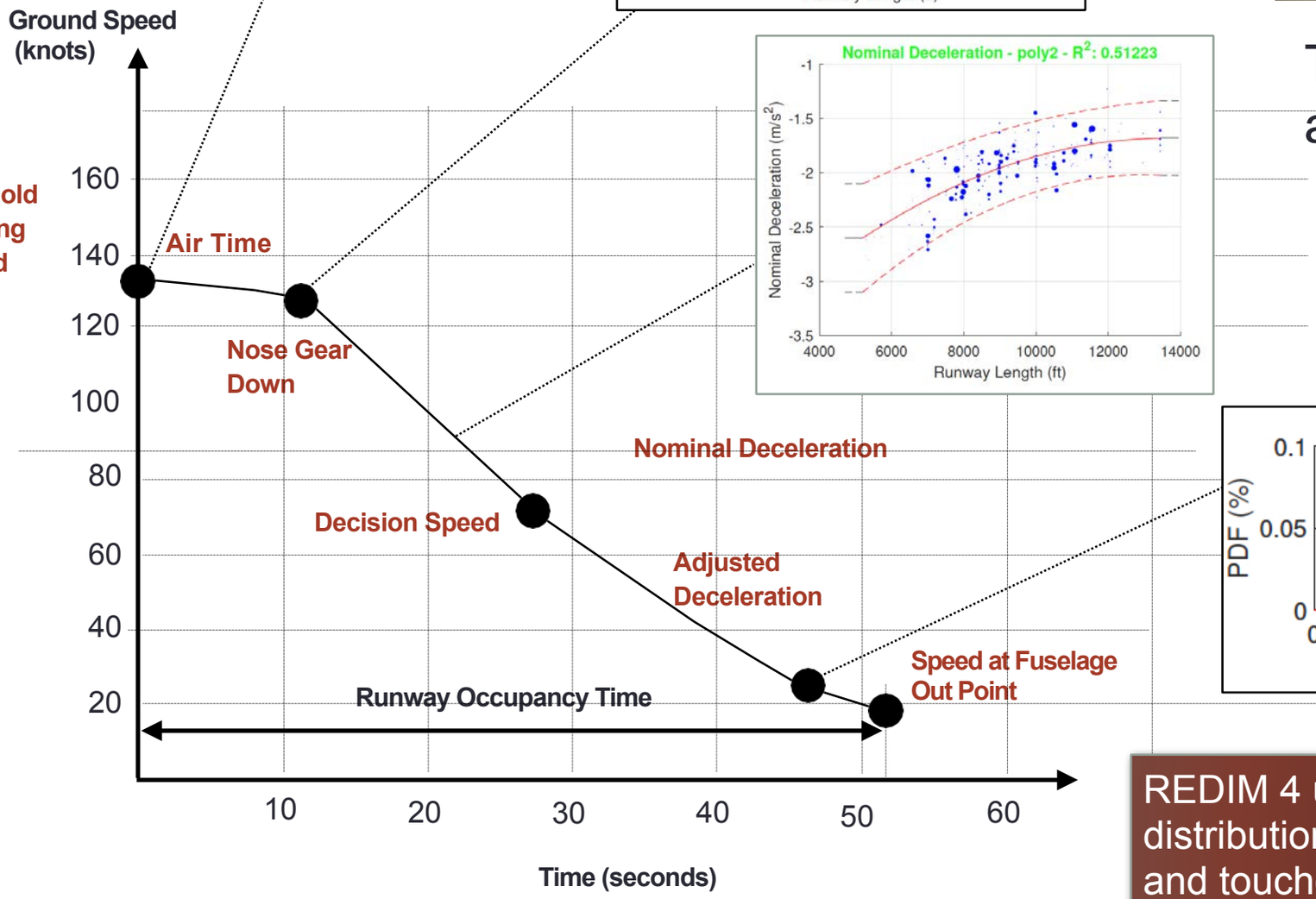
	Angle (deg)		Radius (ft)		Path Length (ft)		Number Of Exits	Type of Runway
Cluster #	Min	Max	Min	Max	Min	Max		Exit
2	30	57	1800	1800	677	1043	96	Acute angle, long radius, midsize path length
6	20	30	1400	1800	1233	1684	63	Acute angle, long radius, long path length



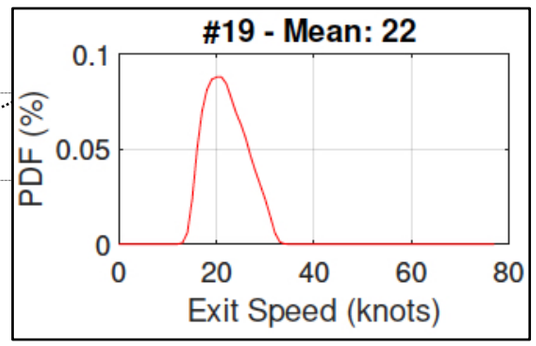
Monte Carlo Simulation in REDIM 4







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)

sign a New Runway
prove an Existing Runway
aluate an Existing Runway
Create New Folder...
AAC A Runs
AAC C Runs
AAC D Runs 9000ft
AAC_B_Runs
Individual_Acft_Runs
Runway13_evaluation
Runway19_DCA
Start Evaluation...
Delete Case Folder
Runway19
Runway Settings
Runway Exit Locations
Runway Occupancy Tim
Tables
Plots
Runway Exit Aircraft Ass
Landing Components Dis
Landing Distances and
Tables
Plots
Edit Runway
Delete Runway

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							

Landing events with a wet runway

All output tables can be exported as Comma Separated Format files

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

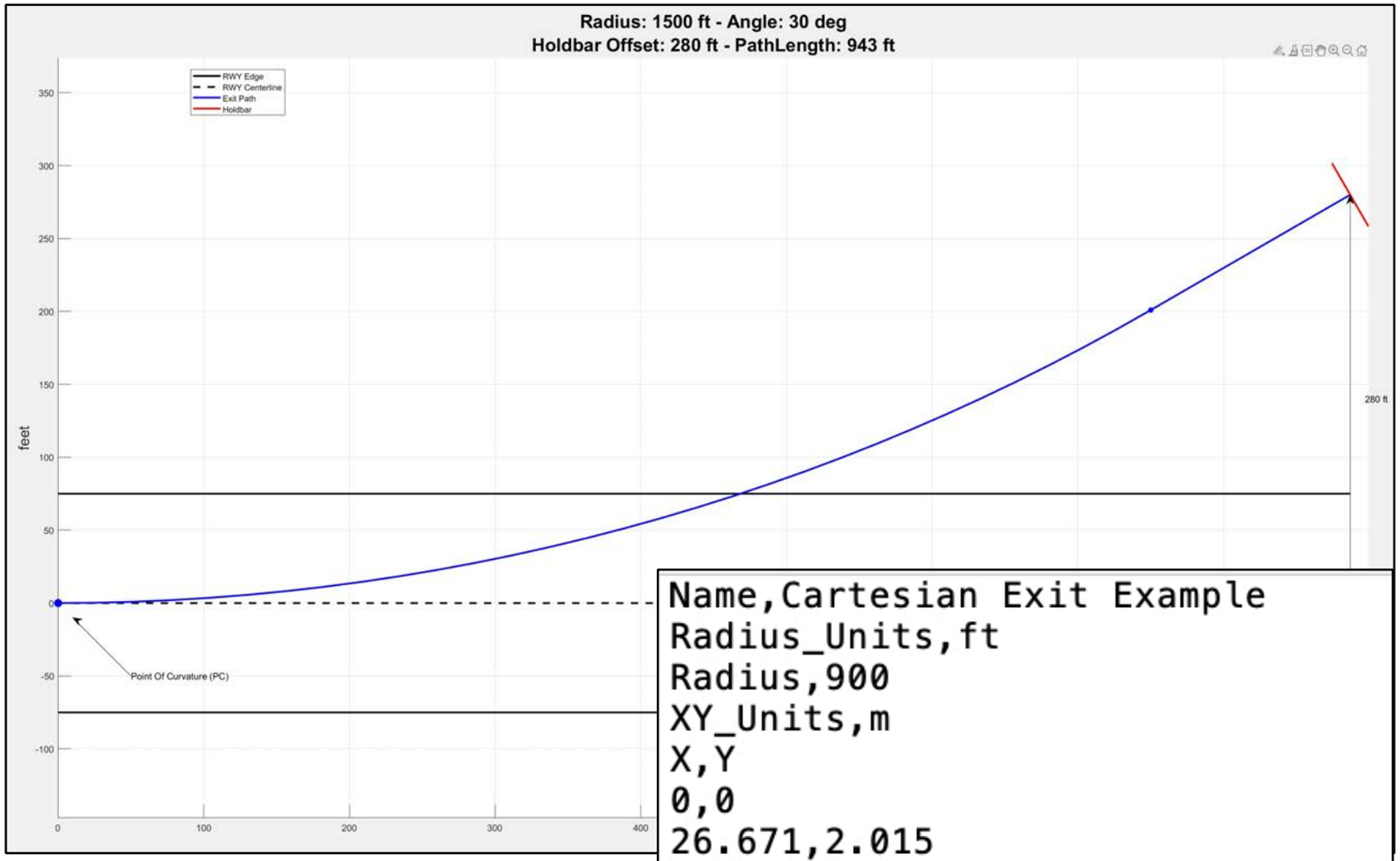
(Runway19)

	Landing Number	Wet Conditions	Exit	Threshold Crossing Speed (knots)	Touchdown Speed (knots)	Nominal Speed (knots)	Speed at PC (knots)	Nominal Deceleration (m/s^2)	Deceleration to PC (m/s^2)	Deceleration after PC (m/s^2)	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)

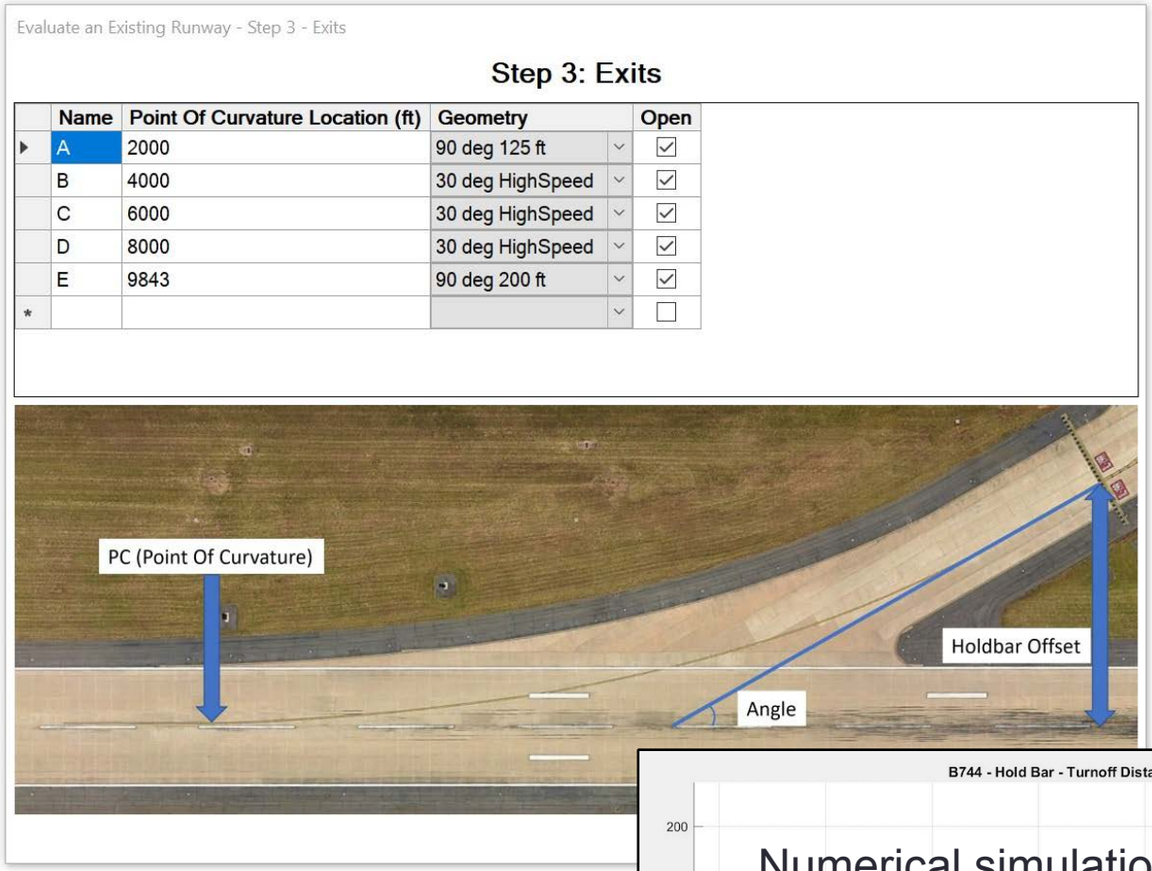
- Standard exit geometry libraries will be in the model to facilitate the runway exit design assessment process
- For custom runway exits (many airports have exits that do not conform to a standard) a user defines runway exits using simple parameters employing cartesian or absolute latitude and longitude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

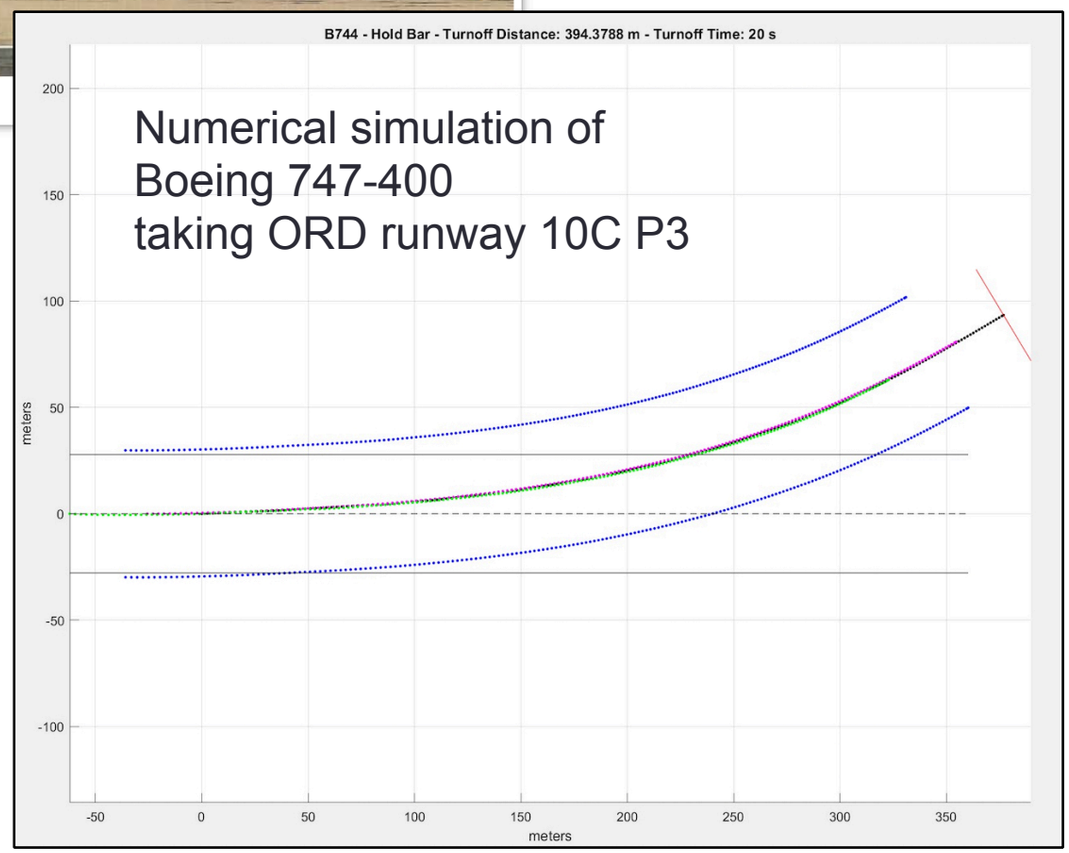



```
Name,Cartesian Exit Example
Radius_Units,ft
Radius,900
XY_Units,m
X,Y
0,0
26.671,2.015
42.047,3.688
57.997,5.654
72.971,8.734
97.812,15.907
113.304,21.596
125.011,26.633
138.622,33.627
152.282,41.414
164.893,49.682
177.397,59.000
292.216,161.161
```

Runway Exit Design Library and Improved Turnoff Simulation

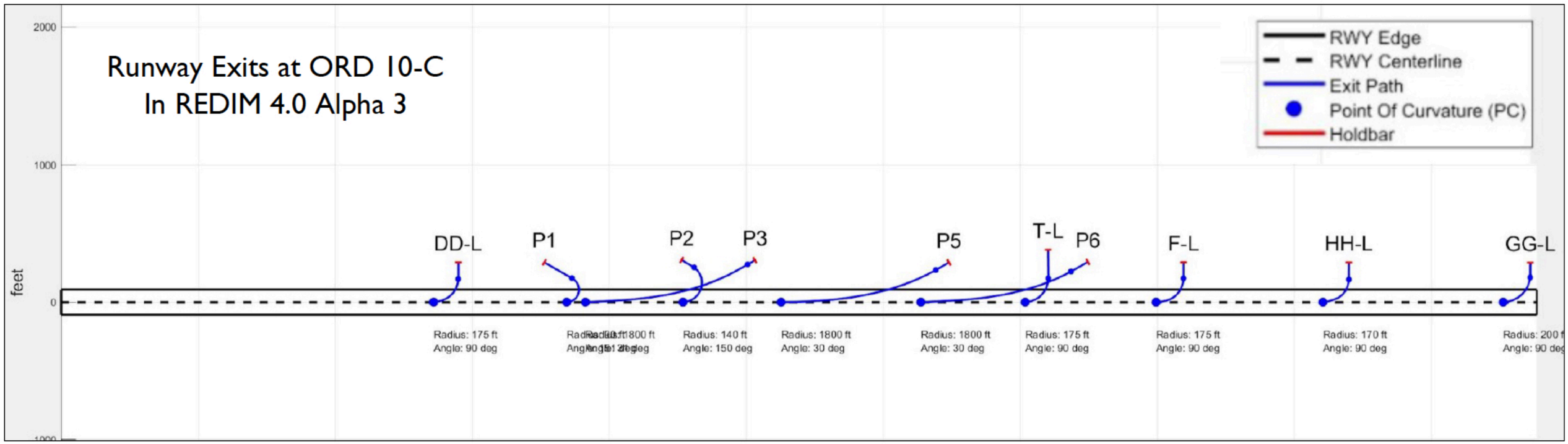
- Purpose is to handle more efficiently how users define runway exits
- A library allows a user to specify either standard of custom exits and just place them along the runway
- Model simulates numerically the path of the aircraft while taking the runway exit





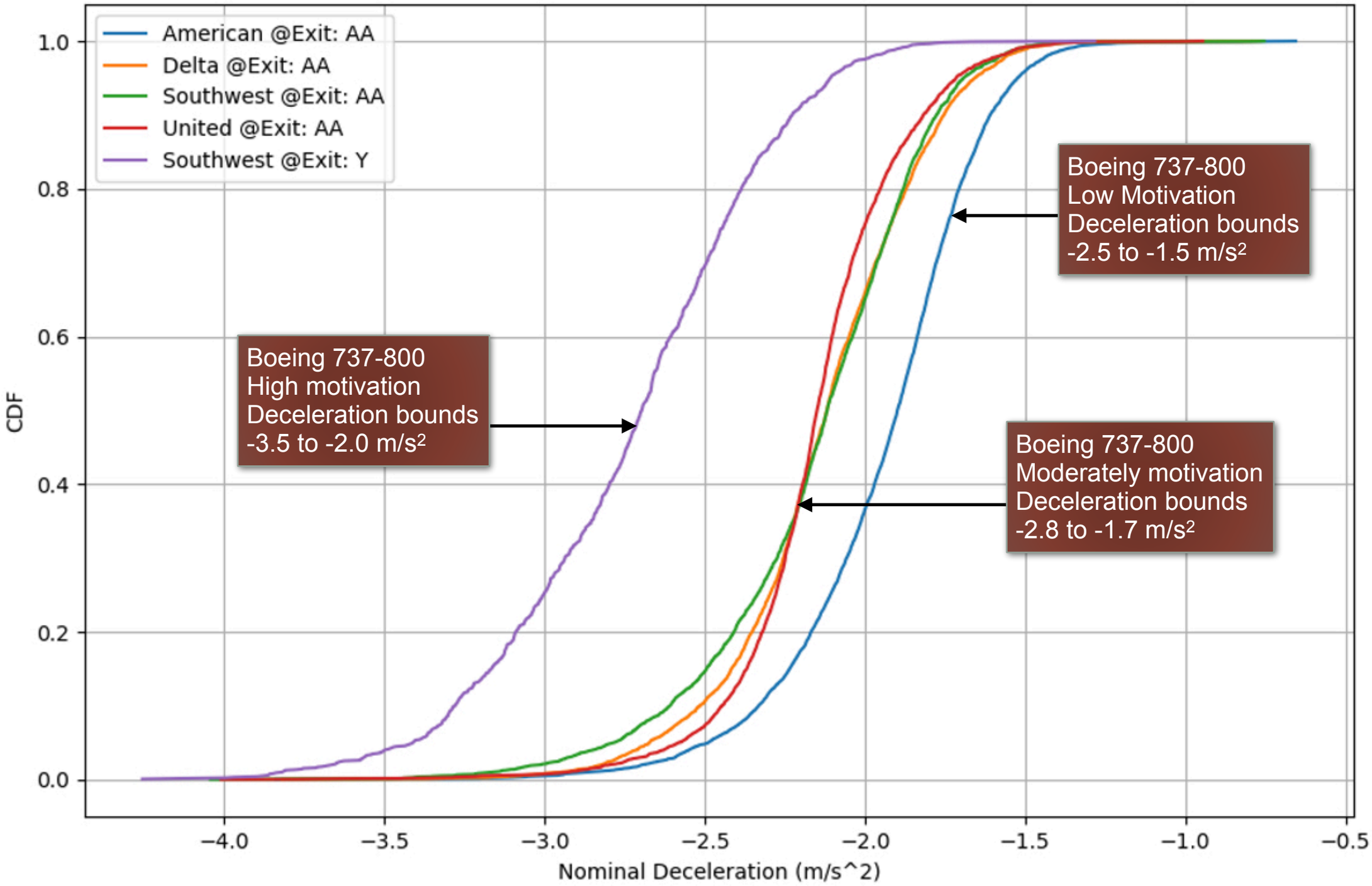
Runway Exits along the Runway (REDIM 4)

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



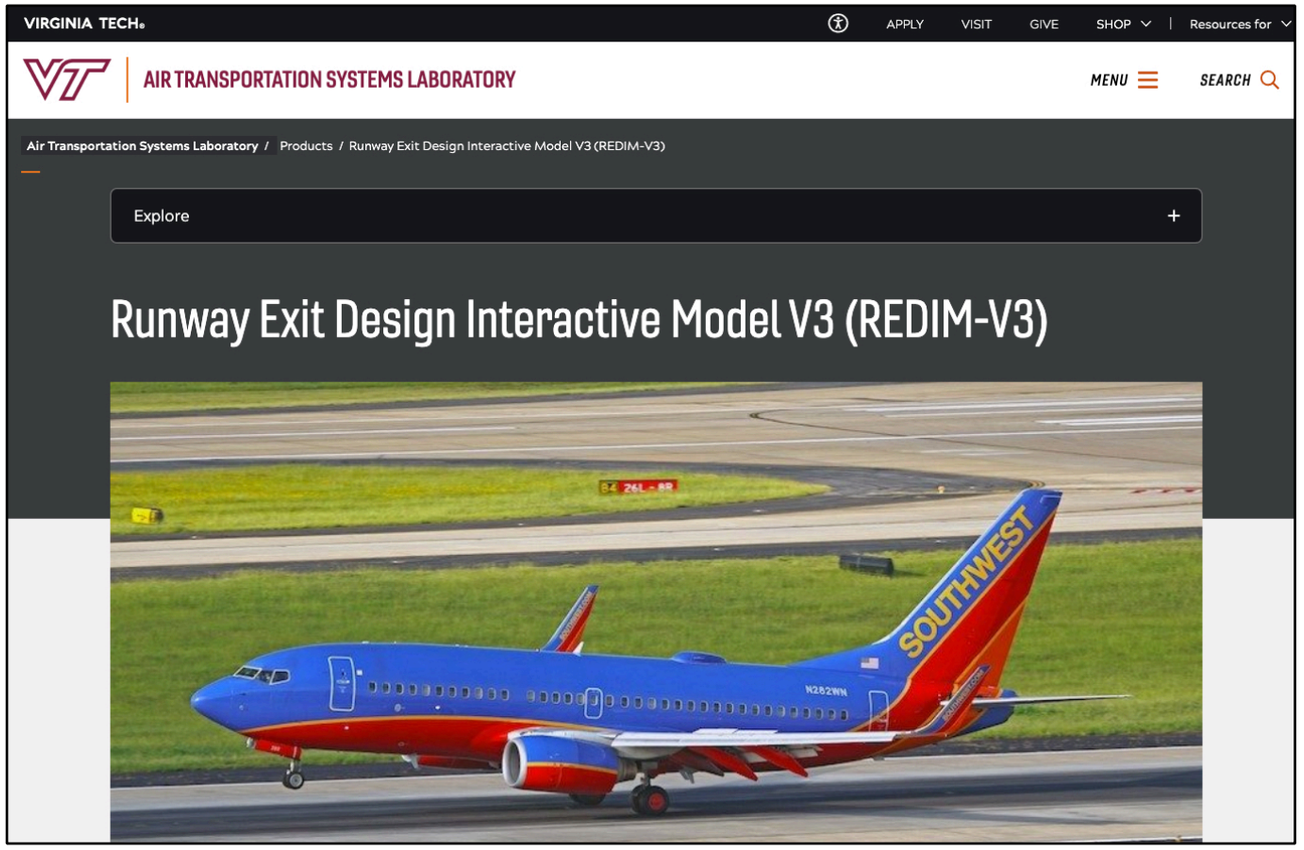
Screen capture of REDIM 4.0

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)
- Nick Hinze (nhinze@vt.edu)



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