Estimating Airport-level Aircraft Activity for Developing Statewide Airport Emissions Inventory

Texas A&M Transportation Institute

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Project Background

- Statewide EIs for all airport source categories, including emissions by aircraft-related activities, are needed to fulfill the EPA's Air Emissions Reporting Requirements and to support state implementation plan development and air quality planning.

- Collecting aircraft-related activities directly from landing facilities (i.e., survey) is the most used way to obtain the inputs needed to estimate emissions by aircraft-related activities. However, it can be challenging to collect the data needed from every single facilities in a state.

- The project is funded by Texas Commission on Environmental Quality (TCEQ) to develop methods to estimate aircraft-related activities in Texas as a quick and inexpensive alternative to survey method. The methods could be modified to be used for other states.

Landing facilities in Texas

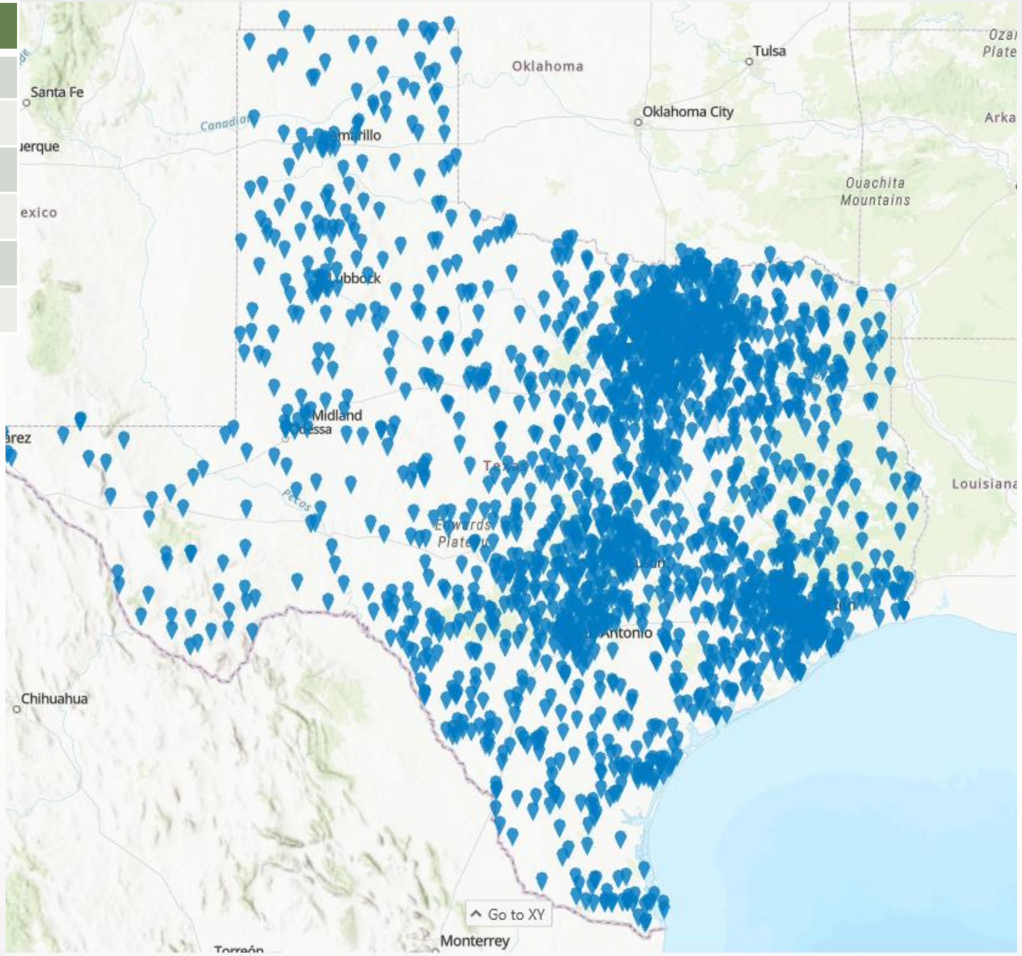
FAA's Landing Facility Group Count

Facility Group	Facility Count
Airport	1,503
Gliderport	*5*
Heliport	561
Seaplane Base	3
Ultralight	8
Total	2,080

Facility Count by TxDOT's Facility Category

Facility Category	Facility Count
Commercial	26
Farm/Ranch	464
Medical	186
Military	20
Other Private Airports	674
Other Private Heliports	349
Other Public Airports	97
Other Public Heliports	3
Reliever	25
TASP Airports	231
Total	2075

TASP: Texas Airport System Plan

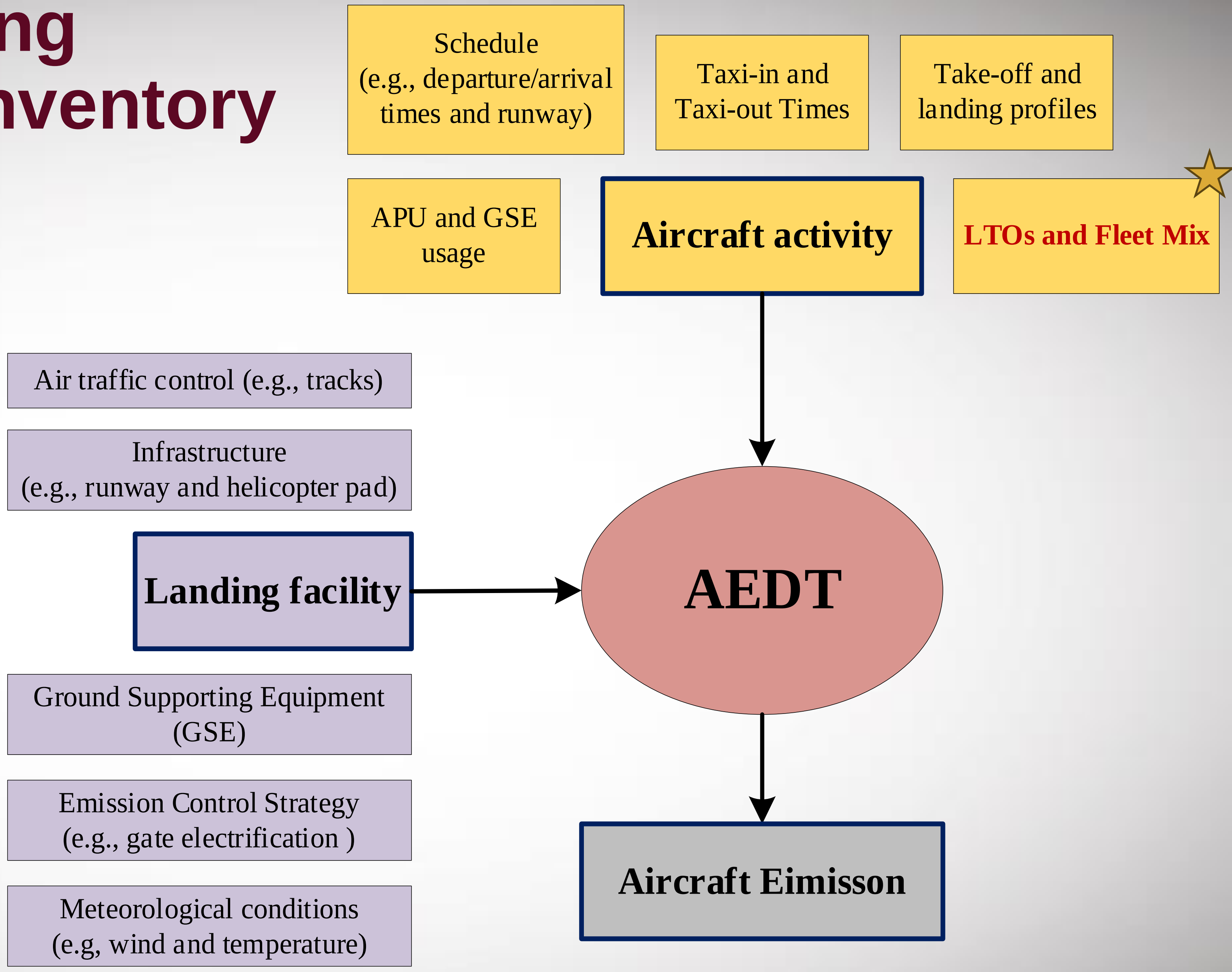


- There are more than 2,000 landing facilities in Texas.
- Collecting aircraft-activity data directly from these landing facilities can be challenging.
- Quick and inexpensive estimation methods need to be developed.

Inputs for Developing Aircraft Emission Inventory

- The primary tool used to develop an airport EI is the FAA's Aviation Environmental Design Tool (AEDT)

- This project is focused on the development LTO and fleet mix
  - ❑ **LTO**: aircraft landing and takeoff operation.
  - ❑ **Fleet mix**: the distribution of LTOs among the combinations of airframe and engine.



Data Sets

- This study reviewed data sets that can be potentially used to estimate LTO and fleet mix.
- This study primarily uses FAA's national data sets that is available to the public for free.
- EPA also used FAA data (T-100, TAF, AMR, and ATDAS) to develop aircraft LTO data.

Data Sources	Brief Description
Terminal Area Forecast (TAF)	The data source contains historical and forecast data for airport operations and based aircraft.
Airport Master Record (AMR)	The data source consists of aeronautical data of both public and private use airports in the US.
Aircraft Registration	The registration data contains airframe and engine information of registered aircraft.
Airline Service Quality Performance (ASQP)	The data source provides air carrier service quality information.
Traffic Flow Management System Counts (TFMSC)	TFMSC data provides information on traffic counts by airport or by city pair for various data groupings such as aircraft type or by the hour of the day.
General Aviation and Part 135 Activity Survey (GA Survey)	The survey enables the FAA to monitor the GA fleet. The survey population usually includes all civil aircraft registered with the FAA that are based in the US or its territories and that were in existence, potentially active in the survey year, and had a valid registration.

LTO Estimation

Level 1: TAF

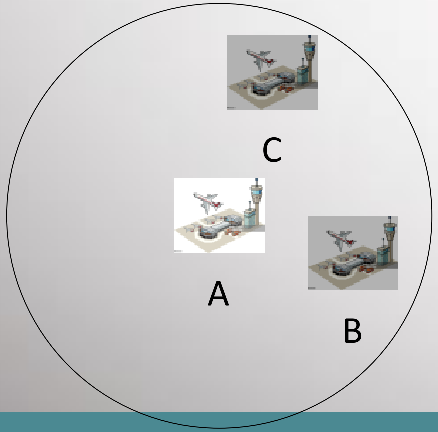
Level 2: FAA AMR

Level 3: Model estimate using base aircraft

GA Survey

- LTOs per based aircraft by aircraft type
- Percentage of itinerant operation by aircraft type

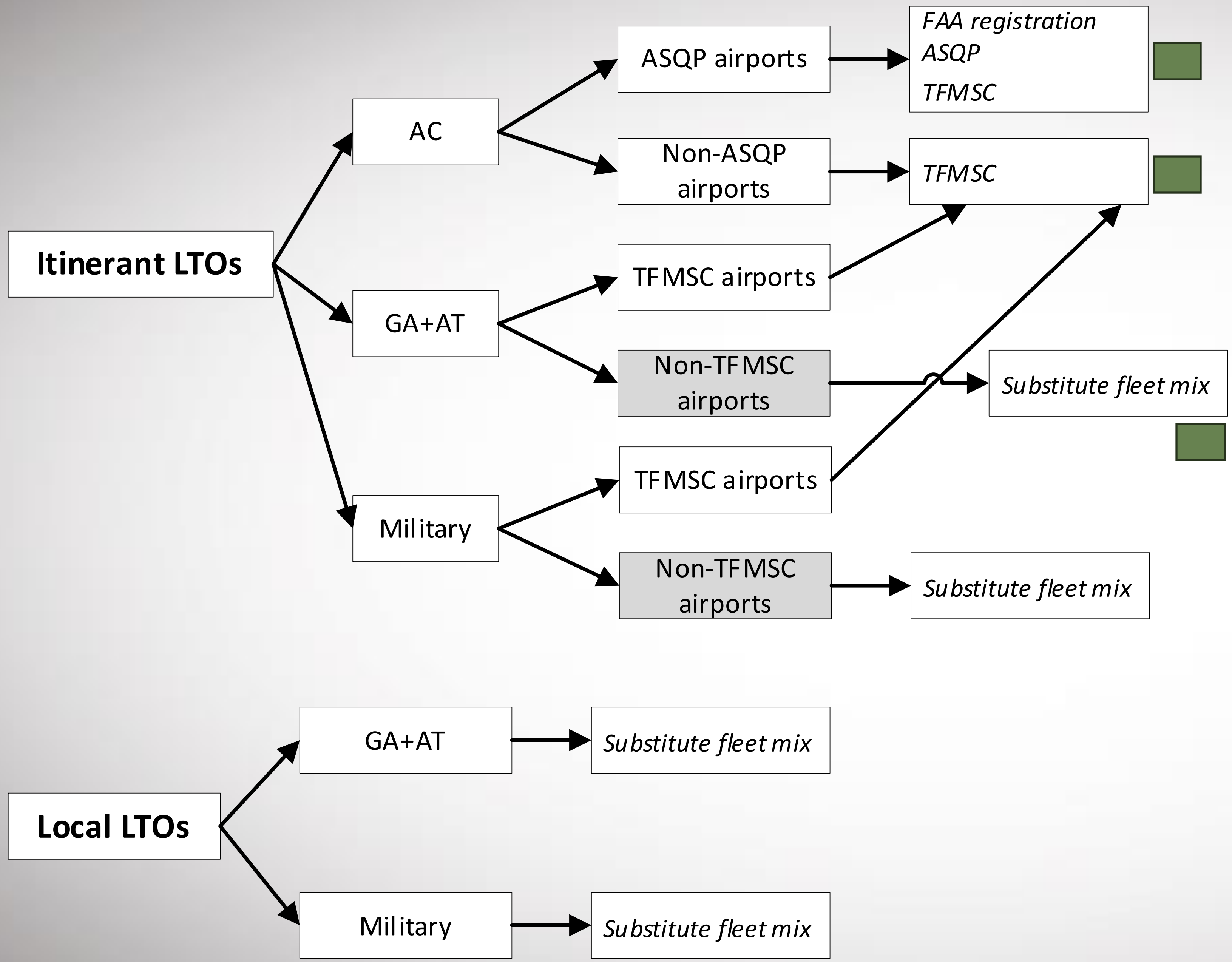
Level 4: Estimated using the LTOs at adjacent facilities



- LTOs are estimated by user class (air carrier, air taxi, general aviation, and military).

Facility category	LTOs by L 1	LTOs by L 2	LTOs by L 3	LTOs by L 4	LTO	Percent
Commercial	1,631,909	0	0	0	1,631,909	31.9%
Farm/Ranch	0	29,096	18,355	18,916	66,367	1.3%
Medical	0	1,721	3,618	21,809	27,148	0.5%
Military	0	0	40,024	300,178	340,202	6.7%
Other Private Airports	0	64,631	131,697	54,851	251,179	4.9%
Other Private Heliports	0	2,053	12,860	27,488	42,400	0.8%
Other Public Airports	0	298,472	6,968	13,735	319,174	6.2%
Other Public Heliports	0	9	0	3,788	3,797	0.1%
Reliever	1,081,653	0	0	0	1,081,653	21.2%
TASP Airports	1,169,352	176,304	3,779	0	1,349,435	26.4%
Total	3,882,913	572,285	217,301	440,765	5,113,263	100.0%
Percent of Total	75.94%	11.19%	4.25%	8.62%	-	-

Fleet Mix Estimation - Overview



- Fleet mix are estimated for itinerant and local LTO separately.
- Different data sets are used for different user class.
- Key steps are
  - ❑ a mapping between airframe and engine model in FAA registration and those in AEDT.
  - ❑ a mapping from the aircraft type in FAA TFMS to airframe and engine model in AEDT.
  - ❑ an airframe and engine model substitute lookup table based on the FAA registration data.

Validation using Data from DFW International Airport

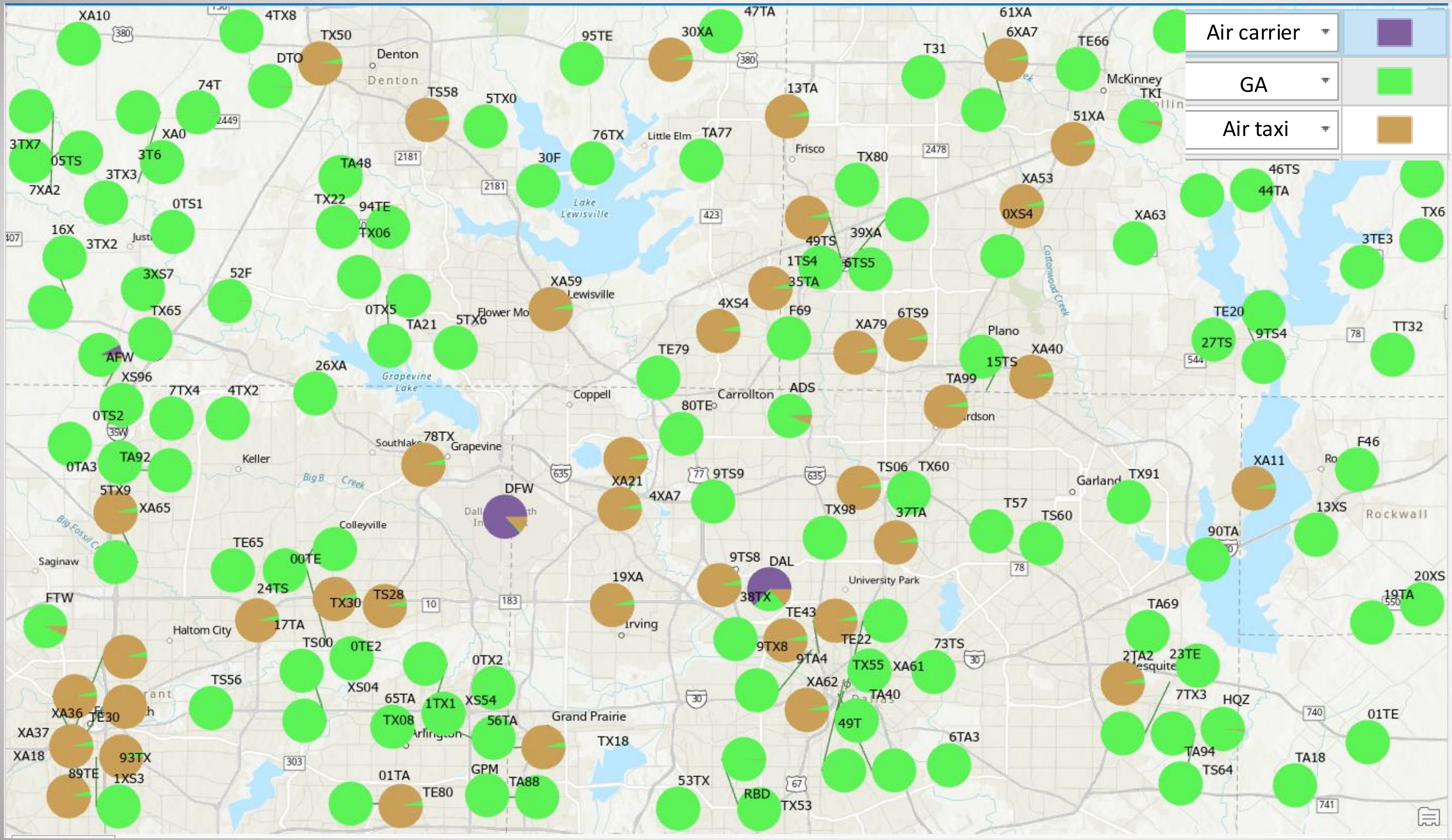
Sample Flight Records from DFWIA Data

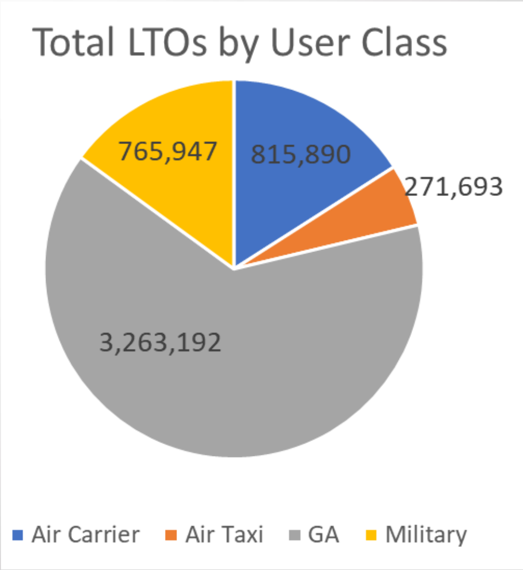
ID	Registration	Departure	Destination	Aircraft subseries	Engine subseries	Primary usage	AEDT ANP
17534626	N644NK	KFLL	KDFW	A320-232	V2527-A5SelectOne	P	A320-232
17534634	N9012	KMIA	KDFW	A319-115	CFM56-5B7/3 PIP	P	A319-131
17534670	N913NN	KLAX	KDFW	737-800	CFM56-7B26E	P	737800
17534701	BLJC	PANC	KDFW	747-8F	GEnx 2B67	F/C	7478

Comparison of 2019 LTOs and Fleet Mix

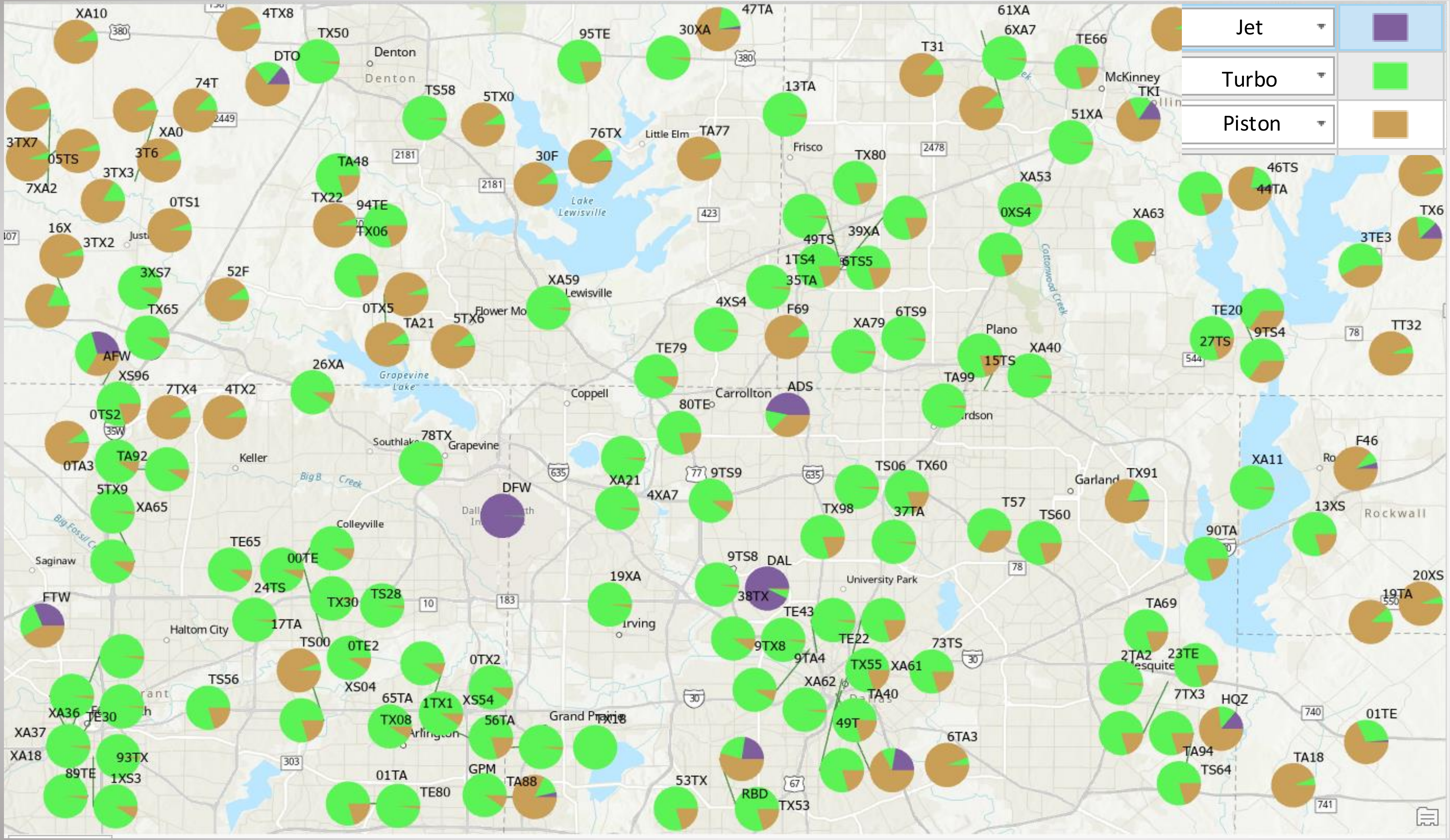
AEDT ANP ID	LTOs (this study)	LTO Percentage (this study)	*LTOs (DFWIA)*	*LTO Percentage (DFWIA)*	*Cumulative percentage (DFWIA)*	LTO Difference
737800	75,276	21.41%	83,985	23.51%	23.51%	-10.37%
CRJ9-ER	39,904	11.35%	56,275	15.75%	39.26%	-29.09%
A321-232	42,854	12.19%	44,304	12.40%	51.66%	-3.27%
EMB170	31,838	9.06%	39,553	11.07%	62.74%	-19.51%
EMB14L	30,683	8.73%	33,836	9.47%	72.21%	-9.32%
A319-131	18,400	5.23%	25,401	7.11%	79.32%	-27.56%
MD83	13,830	3.93%	13,756	3.85%	83.17%	0.54%
A320-232	6,988	1.99%	12,662	3.54%	86.71%	-44.81%
757RR	1,234	0.35%	7,513	2.10%	88.82%	-83.58%
7878R	2,192	0.62%	5,769	1.61%	90.43%	-62.00%

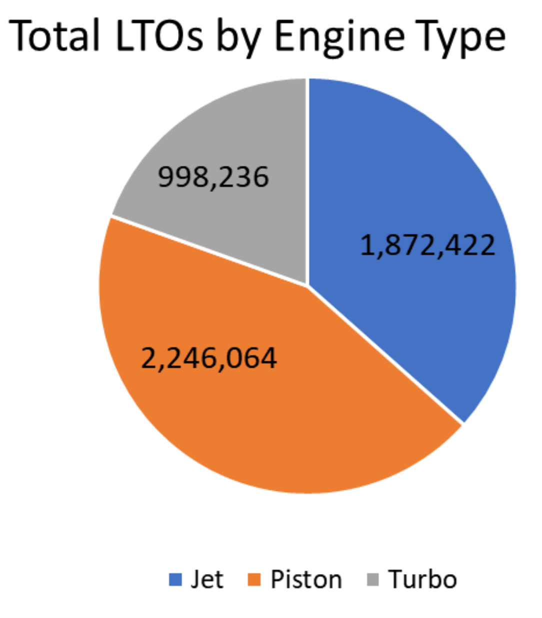
LTO Estimates by User Class



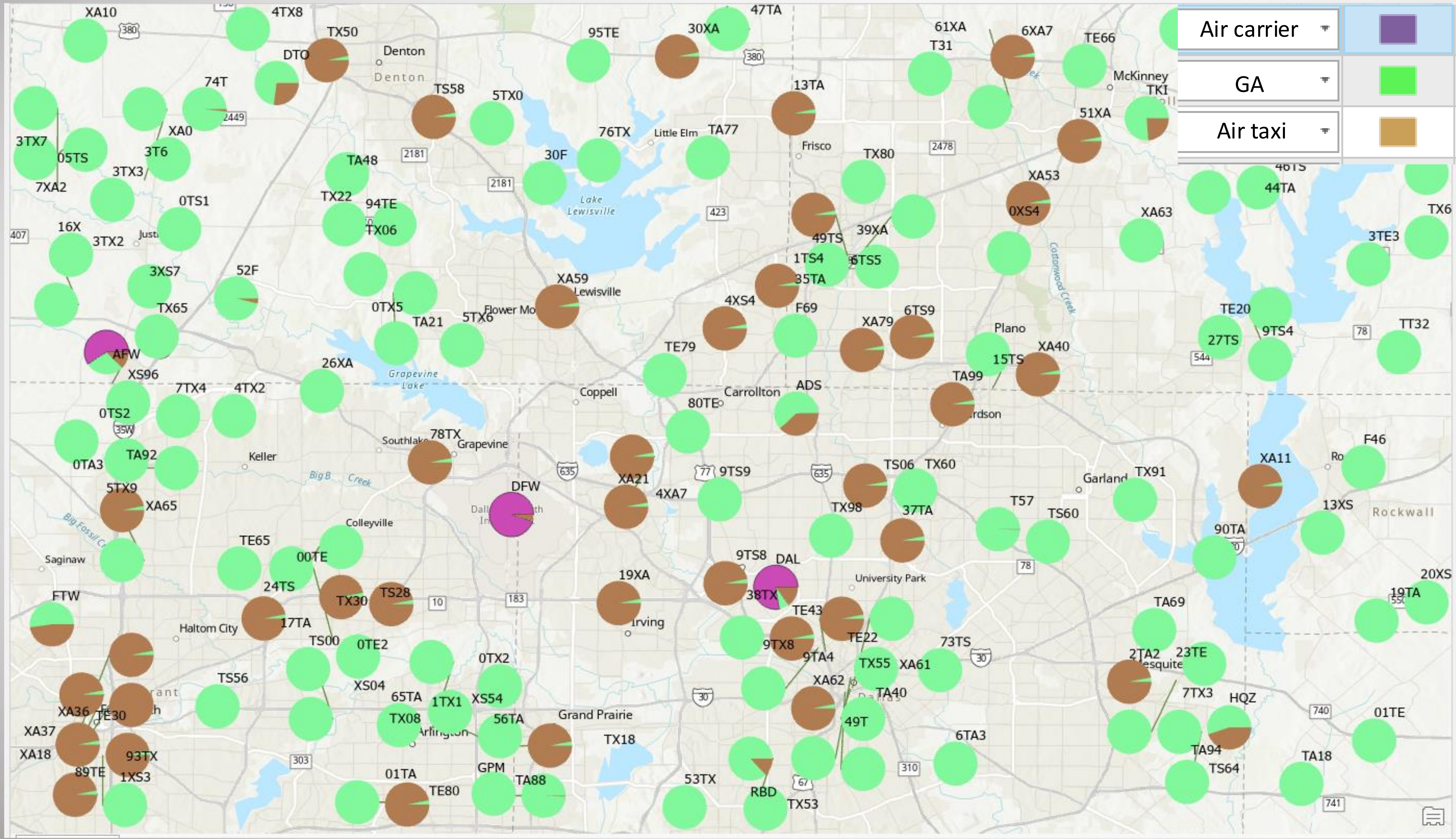


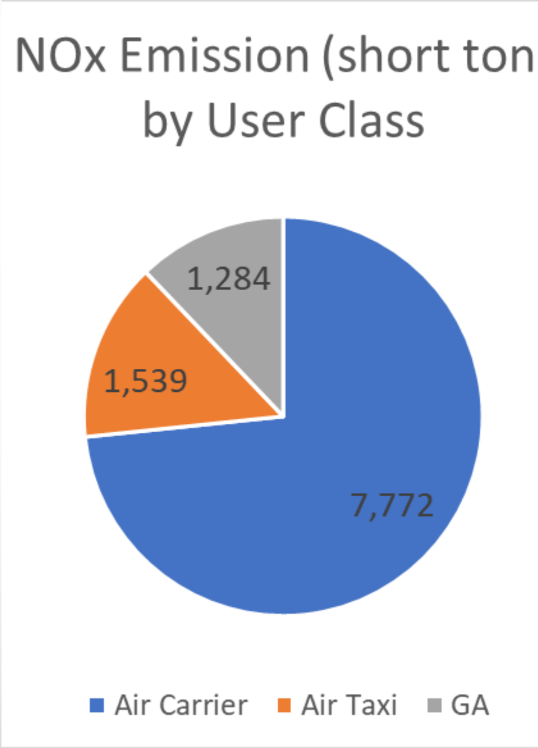
LTO Estimates by Engine Type



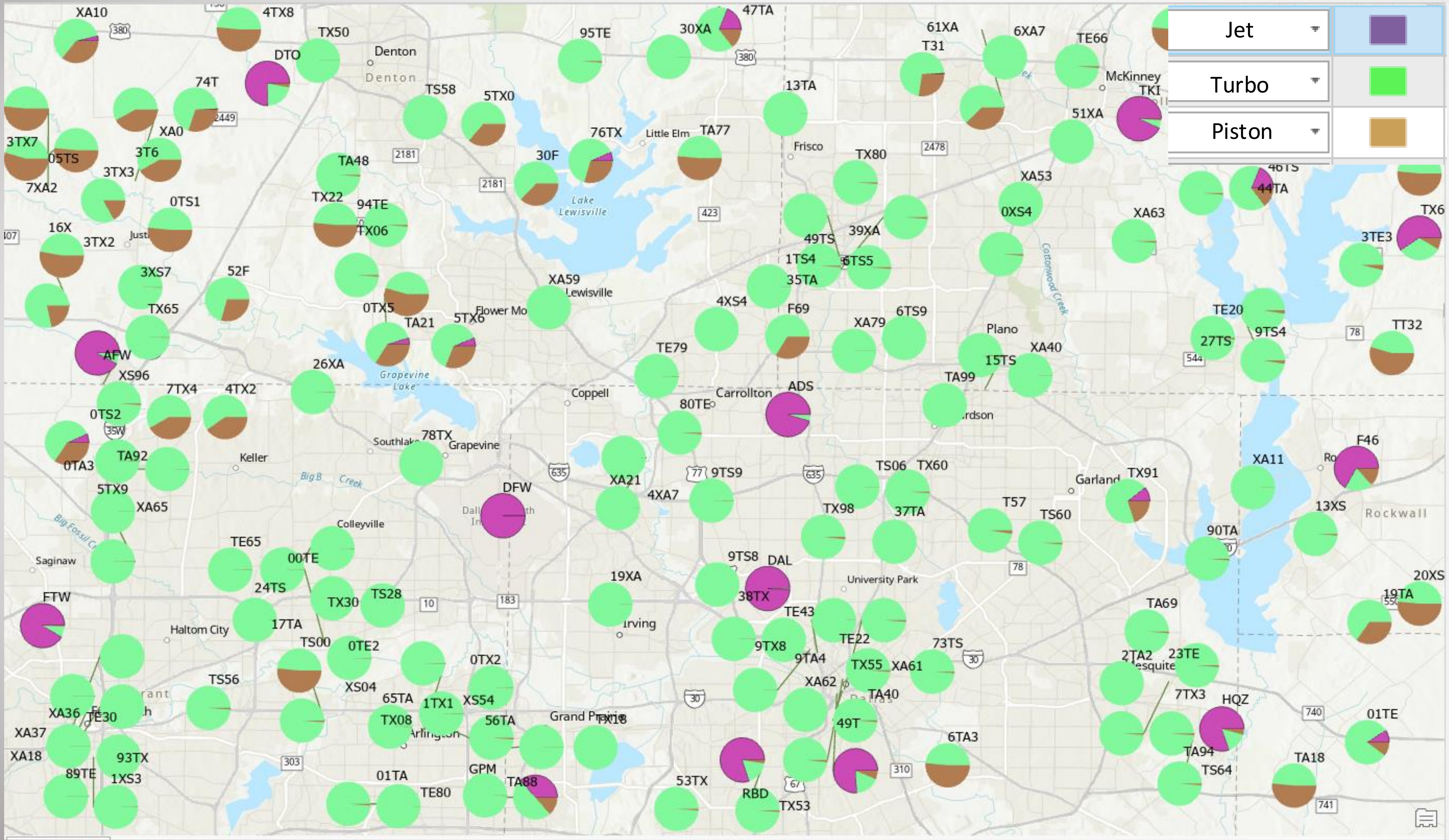


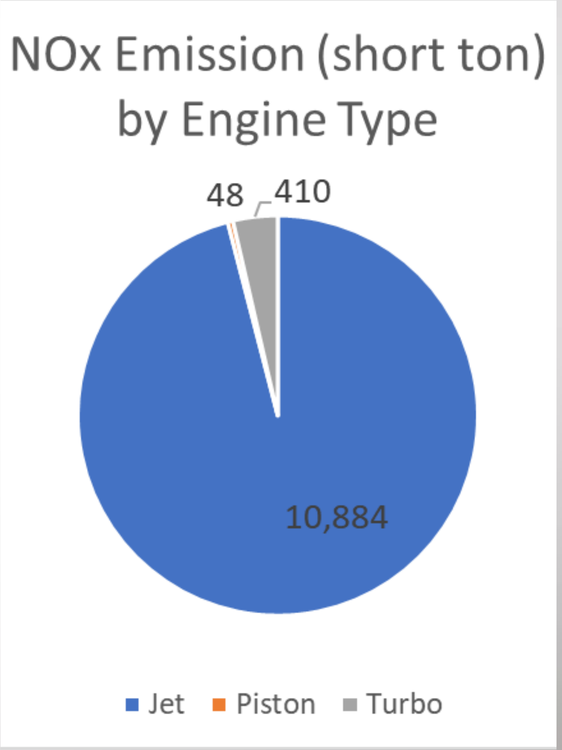
NOx Emission by User Class





NOx Emission by Engine Type





Future Work

1. To explore the possibility of using additional data sources from emerging technologies (e.g., ADS-B data) to estimate and validate aircraft activity as such data sources expand and become more robust.

2. To develop an online dashboard to disseminate important activity data and AEDT inputs used to develop EIs to landing facilities and gather their input and feedback.

Thank you and questions?

Contact Info

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Emissions and Modeling Program

Backup Slides

Sample Records from ASQP and FAA Registration Data

Carrier code	Dept airport	Arrival airport	Date of flight	Gate Departure Time (Actual) in Local Time	Gate Arrival Time (Actual) in Local Time	Wheels-Off Time	Wheels-On Time	Aircraft Tail Number
DL	CVG	ORD	20191201	1916	1935	1938	1928	N8896A
DL	CVG	ORD	20191202	1832	2009	2011	2001	N8896A
DL	JAX	RDU	20191201	622	743	637	738	N186PQ
DL	JAX	RDU	20191202	557	737	619	716	N316PQ
DL	LGA	PIT	20191201	1925	2056	1950	2050	N398CA
DL	LGA	PIT	20191202	0	0	0	0	N138EV
DL	PIT	LGA	20191201	2229	2357	2242	2350	N398CA
DL	PIT	LGA	20191202	0	0	0	0	N325PQ
DL	ATL	SGF	20191201	2037	2145	2111	2140	N925XJ
DL	ATL	SGF	20191202	2038	2128	2053	2124	N329PQ

FAA Registration Data

Engine database

CODE	MFR	MODEL	TYPE	HORSEPOWER	THRUST
30015	GE	CF34 SERIES	5	0	9140

Aircraft database

N-NUMBER	SERIAL NUMBE	MFR MDL CODE	ENG MFR MDL	YEAR MFR
8896A	7896	1390008	30015	2004

Airframe database

CODE	MFR	MODEL	TYPE-ACFT	TYPE-ENG	AC-CAT	BUILD-CERT-IND	NO-ENG	NO-SEATS	AC-WEIGHT	SPEED
1390008	BOMBARDIER INC	CL-600-2B19	5	5	1	0	2	55	CLASS 3	0

Sample Records from TFMSC at DFW Airport

User	Physical	Flight	Aircraft	Departure	Arrival	Total
Air Carrier	Jet	Domestic	A321 - Airbus A321 All Series	3,682	3,688	7,370
Air Taxi	Jet	Domestic	CRJ9 - Bombardier CRJ-900	3,206	3,204	6,410
Air Carrier	Jet	Domestic	E170 - Embraer 170	1,896	1,894	3,790
Air Carrier	Jet	Domestic	E135 - Embraer ERJ 135/140/Legacy	1,824	1,814	3,638
Air Carrier	Jet	Domestic	MD83 - Boeing (Douglas) MD 83	1,472	1,475	2,947
Air Carrier	Jet	Domestic	CRJ7 - Bombardier CRJ-700	1,279	1,269	2,548
Air Carrier	Jet	Domestic	E145 - Embraer ERJ-145	501	499	1,000
Air Carrier	Jet	Domestic	E75L - Embraer 175	399	399	798
Air Carrier	Turbine	Domestic	C208 - Cessna 208 Caravan	308	311	619
Air Carrier	Jet	US to Foreign	B738 - Boeing 737-800	593	0	593

Level 3 LTO Estimation Method

User class	Single Eng	Multi Eng	Jet Eng	Helicopter
Annual LTO Rate	165	186	174	630
Itinerant GA	47.90%	39.80%	61.00%	12.20%
Local GA	48.00%	35.80%	5.70%	48.90%
Itinerant AT	3.60%	24.40%	33.30%	30.90%
Local AT	0.40%	0.10%	0.00%	8.00%

$$lto_{at} = ltorate_{at} \times bn_{at}$$
$$Itnlto_{u,at} = Itnshare_{u,at} * lto_{at}$$
$$Loclto_{u,at} = Locshare_{u,at} * lto_{at}$$

at: is aircraft type.

lto_{at}: is the number of LTOs by aircraft type at.

bn_{at}: is the number of base aircraft for aircraft type at.

$ltorate_{at}$: is the LTO rate of aircraft type at.

$Itnlto_{u,at}$: is the itinerant LTOs for user class u by aircraft type at.

$Loclto_{u,at}$: is the local LTOs for user class u by aircraft type at.

Selected Aircraft for Creating a Substitute Fleet Mix

Frame ID	Airframe Name	Engine ID	Engine Name	Engine Type	Frequency
4658	Bombardier Challenger 600	2110	CF34-3B/-3B1	J	1,699
4682	Cessna 525 CitationJet	1292	JT15D-1 series	J	1,552
4683	Cessna 550 Citation II	1293	JT15D-4 series	J	672
4688	Cessna 560 Citation Excel	1668	PW530	J	665
4776	Dassault Falcon 200	1531	CF700-2D	J	636
4665	Cessna 150 Series	1593	O-200	P	20,445
4666	Cessna 172 Skyhawk	1594	O-320	P	16,935
4667	Cessna 182	1567	IO-360-B	P	16,110
5594	Piper PA-18-150 (FAS)	1594	O-320	P	12,355
4952	Piper PA-28 Cherokee Series	1567	IO-360-B	P	11,668
4960	Pilatus PC-12	1612	PT6A-67B	T	1,131
4669	Cessna 208 Caravan	1595	PT6A-114A	T	881
4636	Raytheon Super King Air 300	1609	PT6A-60A	T	820
5005	EADS Socata TBM-700	1633	PT6A-64	T	760
4642	Raytheon King Air 90	1596	PT6A-135A	T	700
5080	Robinson R44 Raven / Lycoming O-540-F1B5	1715	TIO-540-J2B2	P	1,938
5079	Bell 407 / Rolls-Royce 250-C47B	1339	250B17B	T	1,496
5178	Robinson R22B	1566	IO-320-D1AD	P	1,416
5264	Enstrom 280FX/F-28F	1715	TIO-540-J2B2	P	1,158
4920	Hughes OH-6 Cayuse	1339	250B17B	T	720