ENCLOSURE 4 OF 4

ENCLOSURE 4 TO LETTER F071-L17-007

MITRE

Washington DC Metroplex Post-Implementation Analysis

Sponsor: The Federal Aviation Administration
Dept. No.: F071
Project No.: 0216CA03-SE
Outcome No.: 3
PBWP Reference:3-5.A.1-1, "2016 Metroplex Year-End Progress Report"

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February 2017

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Abstract

The Washington DC Metroplex project focused on the implementation of procedures at Baltimore Washington International Airport (BWI), Ronald Reagan National Airport (DCA), Washington-Dulles International Airport (IAD), and 17 satellite airports. The Washington DC Metroplex project had a phased implementation, beginning in August 2012 and ending in June 2015. In total, 58 procedures and 13 airspace changes were implemented.

The project was initiated based on: (1) predicted fuel savings from improved lateral and vertical flight paths; and (2) an expectation of reduced phraseology, frequency congestion, and pilot/controller workload from de-conflicting procedures and creating more repeatable and predictable paths.

This post-implementation analysis compared airport operations in the months after the final implementation in 2015 to a similar period from 2011, prior to the first implementation. The impacts measured between the pre- and post-implementation data periods result in an extrapolated annual benefit of 2 million gallons ($5.6M) to operators at BWI, DCA and IAD.

Additional benefits beyond individual flight efficiency have also been observed in the data or reported by the affected air traffic facilities, including: reduced controller/pilot transmissions, reduced complexity for pilots and controllers, and more predictable and repeatable flight paths.

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1 Introduction

The Metroplex program is part of the Federal Aviation Administration's (FAA) Next Generation Air Transportation System (NextGen) initiative to modernize the National Airspace System (NAS). Metroplex site implementations involve the development of Performance-Based Navigation (PBN) procedures and the associated redesign of airspace for improved operational efficiency and reduced fuel consumption. Post-implementation impact assessments play a key role in determining each project's success, by measuring the impacts against these objectives.

This report presents the post-implementation impact assessment of the Washington DC Metroplex project relative to the expectations set forth during the Study Phase and later during the Design Phase.

2 Overview of Implementation

The Washington DC Metroplex project implemented 51 Standard Instrument Departures (SIDs) and Standard Terminal Arrivals (STARs), 7 Q/T routes, and 13 airspace changes during a phased implementation process from August 2012 to June 2015. The SIDs and STARs were implemented at Baltimore Washington International Airport (BWI), Ronald Reagan National Airport (DCA), Washington-Dulles International Airport (IAD), and 17 satellite airports.[1]

Several key operational changes resulted from the project's implementation, principally:

- Development of Area Navigation (RNAV) Optimized Profile Descent (OPD) STARs at BWI, DCA, and IAD
- Emphasis on conforming to the new RNAV OPD STARs
- Segregation of arrivals to BWI, DCA, and IAD from the west and south
- RNAV SIDs from all airports
- Segregation of BWI westbound departures and IAD eastbound departures

2.1 BWI Operational Changes

The Washington DC Metroplex implemented five RNAV STARs at BWI. The arrival procedures were designed as OPDs, which include altitude "windows" that allow most aircraft to fly a vertical profile with minimal level flight between top of descent and the runway. Speed restrictions were generally added to help Air Traffic Control (ATC) manage aircraft arrival compression without impacting a flight's ability to maintain an OPD trajectory. En route and runway transitions were added for connectivity, predictability, and to reduce reliance on vectors.

Figure 1 depicts an arrival traffic sample before and after the Metroplex implementation.[2] Lateral shifts in the fights paths are evident close to the airport where runway transitions were added to the STARs. Additionally, many of the new RNAV STARs show less lateral dispersion.

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[1] Richmond International Airport is considered a satellite airport for the purpose of this document.

[2] BWI track data depicted in Figures 1 and 2 is a sample of 6 pre-implementation days and 6 post-implementation days

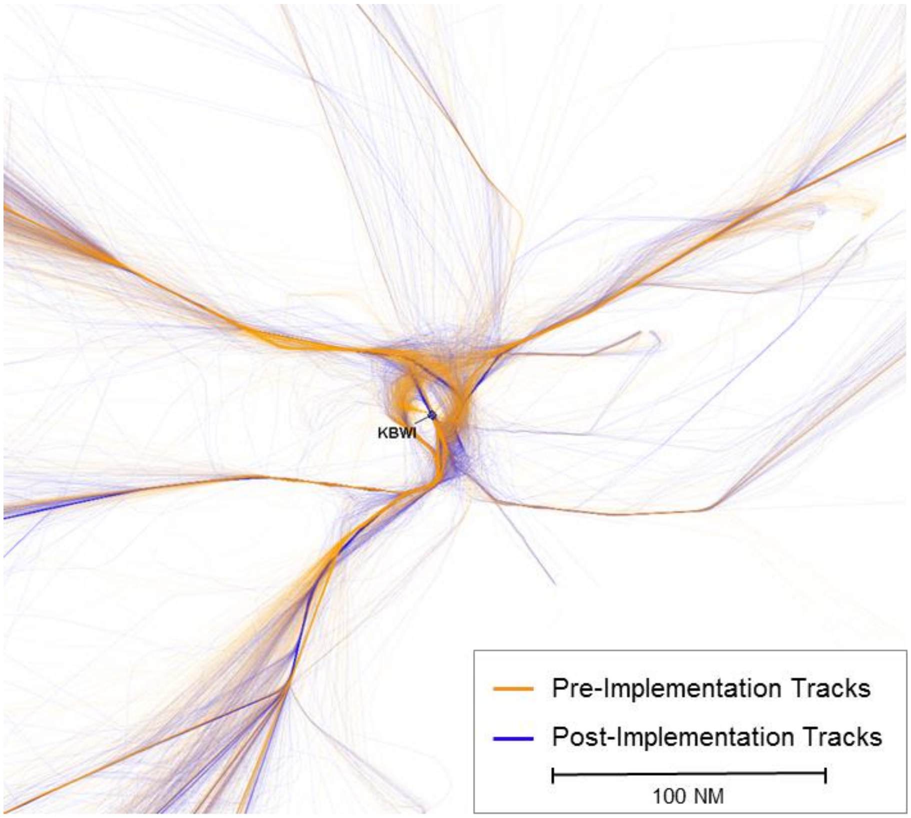

Figure 1. BWI Arrival Tracks

The Washington DC Metroplex also implemented five RNAV SIDs at BWI, one of which is designed as a Severe Weather Avoidance Plan (SWAP) route. The SIDs were designed to improve en route connectivity and de-conflict from other procedures within the DC Metroplex. Figure 2 depicts a departure traffic sample before and after Metroplex implementation. More direct routings to the west, southwest, and south are apparent near the airport.

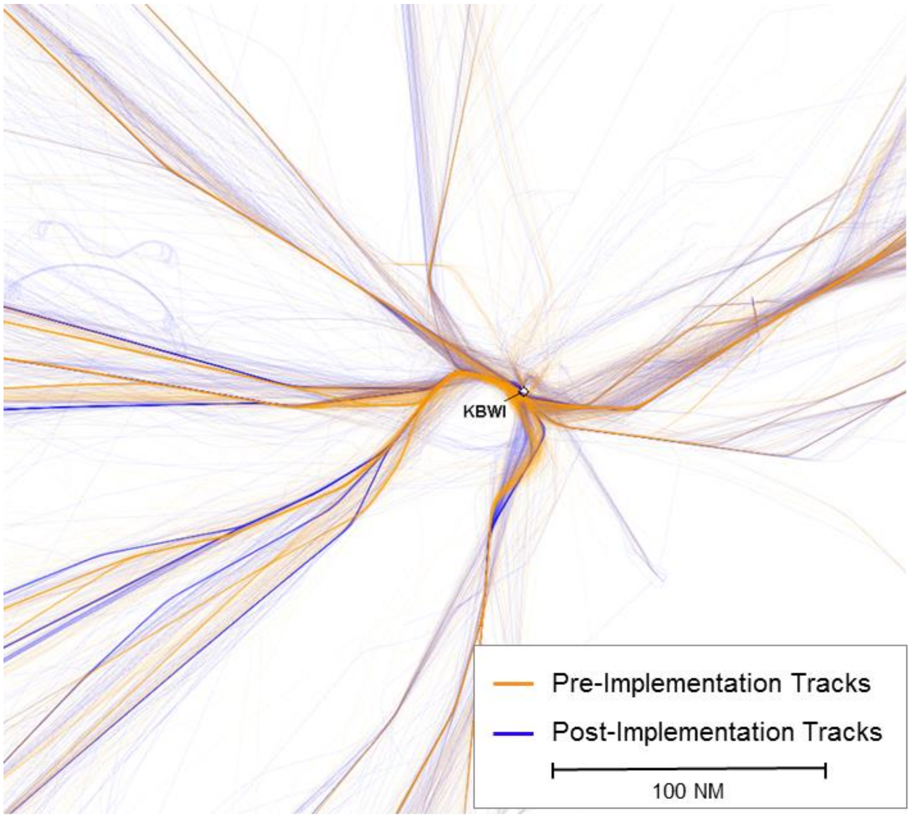

Figure 2. BWI Departure Tracks

2.2 DCA Operational Changes

Four RNAV OPD STARs were implemented at DCA as part of the Washington DC Metroplex project to reduce level flight and distance flown. These STARs also added runway transitions to increase predictability and reduce reliance on vectoring. Figure 3 depicts an arrival traffic sample before and after the Metroplex implementation.[3] Lateral shifts in the fights paths are evident from the west and south, which align with the lateral paths of the new procedures. Additionally, many of the new RNAV STARs show less lateral dispersion.

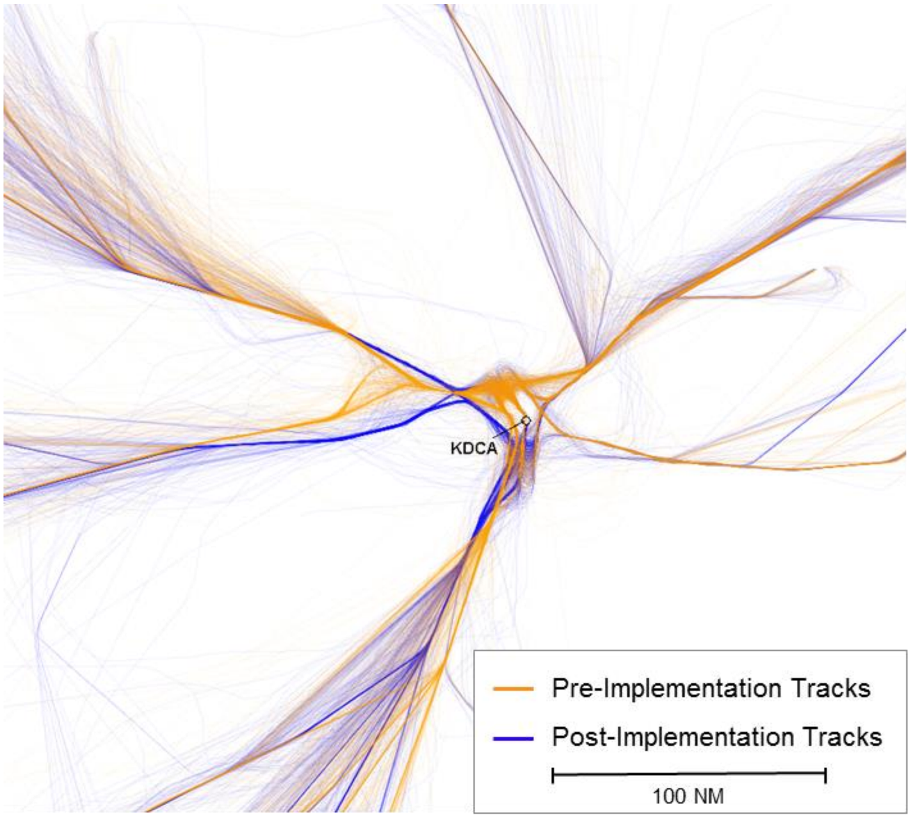

Figure 3. DCA Arrival Tracks

[3] DCA track data depicted in Figures 3 and 4 is a sample of 6 pre-implementation days and 6 post-implementation days.

The Washington DC Metroplex Team also designed nine RNAV SIDs at DCA. These RNAV SIDs fly over the river rather than nearby communities, while also avoiding protected airspace. The RNAV SIDs improve upon the previous RNAV SID design by providing connectivity with departure gates and reducing reliance on vectors. Figure 4 depicts a departure traffic sample before and after the Metroplex implementation.

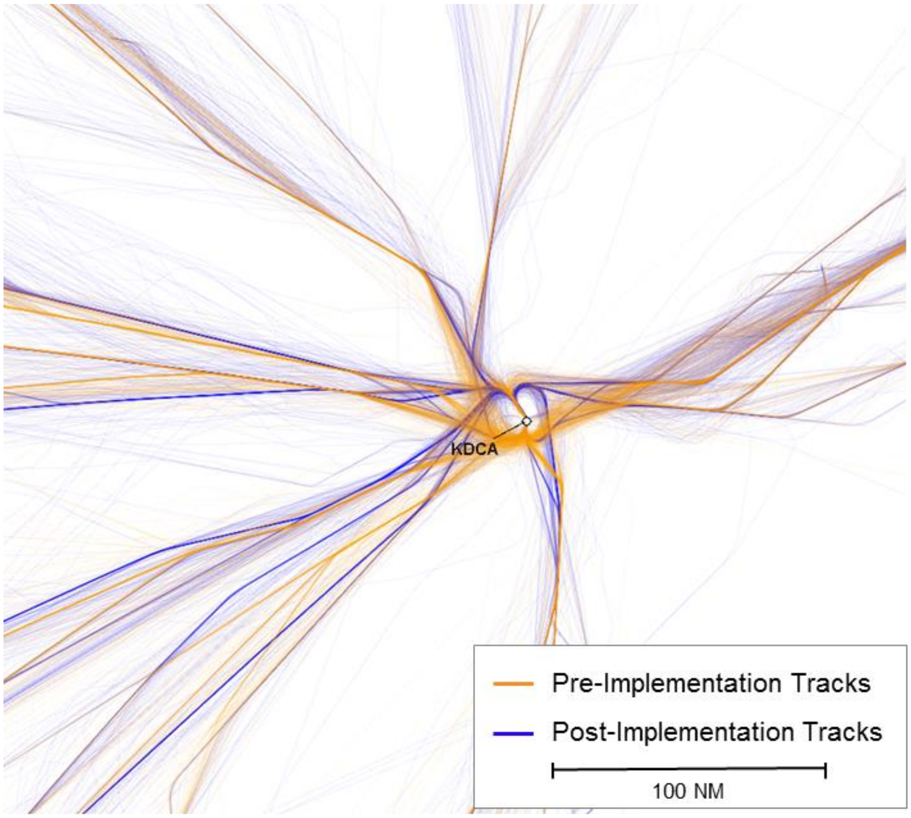

Figure 4. DCA Departure Tracks

2.3 IAD Operational Changes

The Washington DC Metroplex project implemented four RNAV OPD STARs at IAD. Runway transitions were added to arrivals from the northeast to increase predictability and reduce reliance on vectoring. The Runway 1L transition created a west downwind for IAD arrivals from the northeast, which added flexibility for ATC when sequencing aircraft.

Figure 5 depicts an arrival traffic sample before and after the Metroplex implementation.[4] Lateral shifts in the fights paths are evident from all directions, particularly noticeable from the west and north, and generally align with the lateral paths of the new STARs.

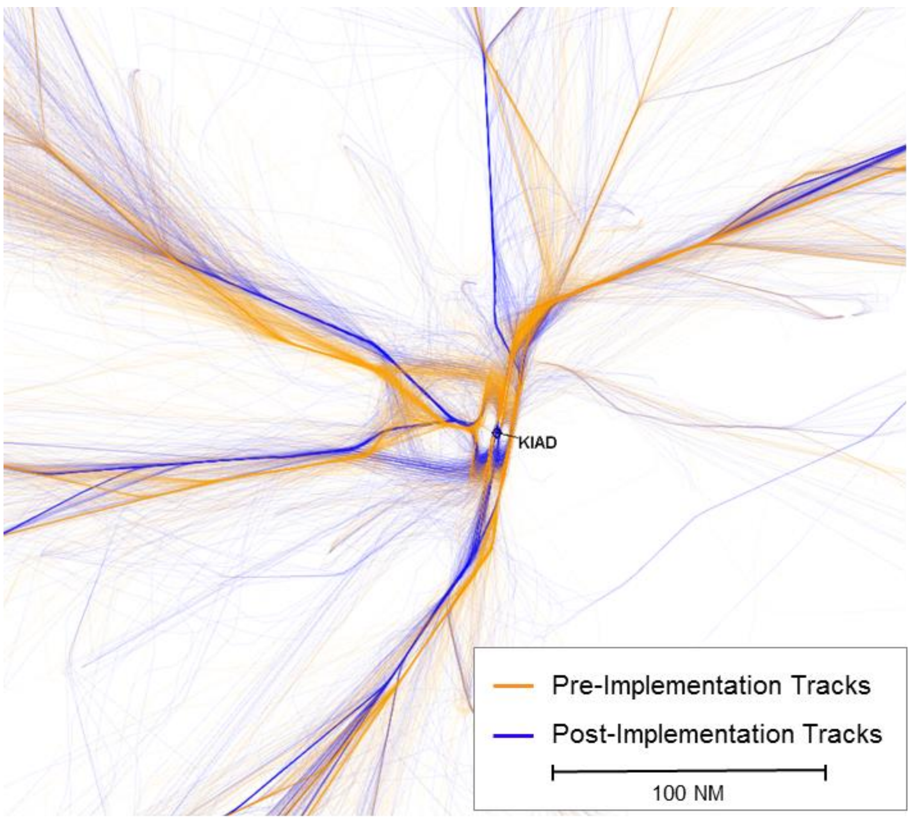

Figure 5. IAD Arrival Tracks

[4] IAD track data depicted in Figures 5 and 6 is a sample of 6 pre-implementation days and 6 post-implementation days.

The Metroplex project also implemented seven RNAV SIDs at IAD to increase connectivity to en route jet routes and reduce reliance on vectors. Eastbound and southbound departures were modified to decrease the potential interactions with BWI departures and allow for more efficient routing around and through the Flight Restricted Zone (FRZ) above DCA.[5] The procedures were initially designed as RNAV off-the-ground SIDs, though IAD tower preferred to vector flights off the runway before joining the SID to utilize diverging departure headings and provide more direct routings. Figure 6 depicts a departure traffic sample before and after Metroplex implementation. Lateral shifts are apparent for west and southwest departures.

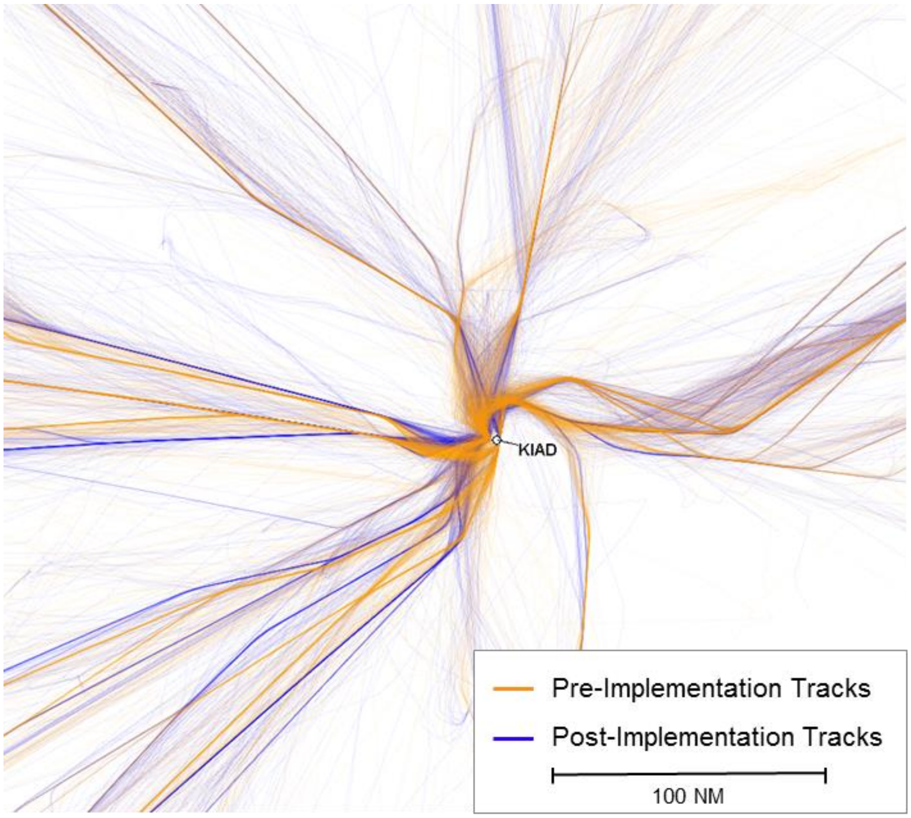

Figure 6. IAD Departure Tracks

3 Methodology

This post-implementation analysis examined flight efficiency metrics and traffic flow management metrics in the time periods before and after the Metroplex implementation at Washington, DC.

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[5] The JCOBY SID provides a routing for Federal Aviation Regulation (FAR) Part 121 aircraft to take a shortcut through the FRZ. General aviation and international carriers are required to go around the FRZ except in cases where pilots have obtained prior authorization.

The flight efficiency metrics include modeled fuel consumption, distance flown, time flown, and distance flown in level flight. The traffic flow management metrics include arrival rates, throughput, delays, vectoring, holding, and Miles-in-Trail (MIT) restrictions.

This analysis only focused on the three major airports within the Washington, DC Metroplex: BWI, DCA, and IAD.

3.1 Data Collection

Flight efficiency metrics were calculated from The MITRE Corporation's Center for Advanced Aviation System Development (MITRE CAASD) Threaded Track and Flight Story data. Threaded Track data merge airport, terminal, and center radar sources to obtain a composite trajectory from the departure airport to the arrival airport. Flight Story derives information from Threaded Track and other data sources to produce additional metrics, including modeled fuel consumption, distance flown, and time flown.

Flight efficiency metrics were collected from 1 August 2011 to 20 November 2011 for the pre-implementation period and 3 August 2015 to 22 November 2015 for the post-implementation period. The post-implementation time period purposely excluded the first weeks after the final implementation to allow NAS operations and controllers to become accustomed to the new procedures before collecting metrics. The pre-implementation time period is a similar time of year as the post-implementation time period, shifted to match the day of the week, prior to the initial implementation in August 2012.

The sampling period for BWI was reduced due to a runway closure in 2015, and only included approximately one month of data for the pre- and post-implementation period: 1-29 August and 17-20 November, 2011 and 3-31 August and 19-22 November, 2015.

Traffic flow management metrics were analyzed on a continual basis from 1 January 2011 to 31 December 2015.

Due to the phased implementation schedule, some post-implementation amendments were completed prior to and during the analysis period, including DCA STARs from the NW and SW and IAD STARs from the NE, NW, and SW. Benefits from these amendments are included in the analysis results.

3.2 Analysis Methodology

Depending on the distance between the Metroplex airport and non-Metroplex airport for a particular flight, the flight efficiency metrics were calculated at three corresponding radii:

1. If the non-Metroplex airport was more than 450 nautical miles (NM) away from the Metroplex airport, flight efficiency metrics were calculated between a 300 NM radius from the Metroplex airport and the runway threshold of the Metroplex airport. The 300 NM radius was chosen based on observation from manual inspection that similar operations (e.g., based on origin or destination) both pre- and post-implementation enter or exit the 300 NM radius at roughly the same location.
2. If the non-Metroplex airport was between 300 NM and 450 NM of the Metroplex airport, flight efficiency metrics were calculated between a 150 NM radius from the Metroplex airport and the runway threshold of the Metroplex airport. The 150 NM radius ensured the runway configuration of the non-Metroplex airport did not impact the flight efficiency metrics for these flights.

3. If the non-Metroplex airport was within 300 NM from the Metroplex airport, flight efficiency metrics were calculated between the runway threshold of the non-Metroplex airport and the runway threshold of the Metroplex airport.

A meaningful comparison across these three groups of flights is not possible because each spends a varying amount of time in the different phases of flight (i.e., climb, cruise, descent) within 300 NM of the Metroplex airport.

Flights were grouped into subsets, and similar subsets in the pre- and post-implementation data sets were compared to each other. These subsets were determined by:

- Radii used to calculate flight efficiency metrics
- Aircraft type
- Flow, this was determined by the azimuth value that each flight crossed the 300 NM radius, or the individual non-Metroplex airport if the airport was within 450 NM of the Metroplex airport
- Arrival/departure runway at the Metroplex airport
- Arrival/departure runway at the non-Metroplex airport for aircraft arriving/departing within 300 NM of the Metroplex airport.

Flights not expected to be impacted by the Metroplex implementation were removed from the analysis, including:

- Piston, helicopter, and military aircraft
- Nighttime operations arriving or departing between 2300 and 0559 local time
- Flights that experienced moderate or severe weather[6]
- Flights that experienced holding.[7]

If any given subset had less than 15 comparable flights after filtering in the pre- or post-implementation data sets, it was not used to calculate the flight efficiency metrics. This was done to limit the impact of outlier flights.

Once the metrics were calculated for each qualifying subset, the data were aggregated to determine the metrics for the individual airport or flow. These track sets were then aggregated and weighted by the number of operations to determine the metrics for each general direction and Metroplex airport.

Due to the phased implementation schedule and four-year difference between pre- and post-implementation data, there were many non-Metroplex changes that were difficult to control for, which impacted the results. These include cruise altitudes, climb rates, procedure changes at nearby airports, and winds.

MITRE CAASD used EUROCONTROL's Base of Aircraft Data (BADA) equations to model fuel and assumed max thrust in the climb phase of flight regardless of the climb gradient. A

[6] Weather impact is collected from the FAA's Aviation System Performance Metrics (ASPM) database.

[7] Holding flights were eliminated from flight efficiency metrics but tracked separately to understand if the Metroplex implementation impacted the amount of holding.

lower climb rate results in an increase in time spent in the climb phase of flight, which increases the modeled fuel burn given the max thrust assumption.

Additional non-Metroplex changes were accounted for in this analysis:

- The DC Metroplex team did not create procedures for BWI east departures or DCA northeast arrivals. These flights were not included in the flight efficiency metrics.
- The post-implementation data period contained DCA departures that flew an alternate routing to LaGuardia Airport (LGA). This alternate routing greatly increased distance flown and modeled fuel consumption, but was not a result of the DC Metroplex implementation. These flights were not included in the flight efficiency metrics.

4 Expected Benefits

The Study Team predicted that the recommended designs would provide 2.2 million gallons in modeled fuel consumption savings. These benefits were projected to mainly result from the implementation of OPD STARs at BWI, DCA, and IAD.

The Design Phase Executive Summary described the final procedure designs, including the OPDs for BWI, DCA, and IAD. The Design and Implementation (D&I) Team modified the lateral and vertical paths of the Study Team designs. They also proposed new procedures for DC satellite airports. The D&I Team predicted their recommended designs would provide 2.1 million gallons in modeled fuel consumption savings.

Both the Study Team and D&I Team designs segregated BWI, DCA, and IAD jet arrivals from the west and south to increase efficiency, improve access, and reduce air traffic task complexity. Repeatable and predictable flight paths, and reduced pilot/controller communications were also expected as a result from the Metroplex implementation.

5 Findings

The modeled fuel consumption between the pre- and post-implementation data sets resulted in an annualized benefit of 2.0 million gallons to operators at BWI, DCA, and IAD. The primary drivers of the modeled fuel benefits were reductions in level flight, distance, and time flown for arrivals. The modeled fuel consumption benefits were greatest for IAD, which realized a savings on both arrivals and departures, whereas BWI and DCA saw a savings for arrivals but a cost for departures. Table 1 summarizes the change in modeled fuel consumption and associated savings at BWI, DCA, and IAD. A positive number represents a savings, while a negative number represents a cost.

Table 1. Modeled Fuel Consumption Results

Airport	Operation	Average Fuel Savings (Gallons per Flight)	Contributing Operations (Annualized)	Fuel Savings (Annualized Gallons)	Fuel Savings (Annualized Dollars) †
BWI	Arrivals	3.4	100,029	335,000	956,000
	Departures	-1.8	101,765	-181,000	-515,000
BWI Subtotal		0.8	201,793	155,000	441,000
DCA	Arrivals	4.5	129,513	581,000	1,655,000
	Departures	-2.5	102,570	-257,000	-733,000
DCA Subtotal		1.4	232,082	324,000	922,000
IAD	Arrivals	9.6	99,700	992,000	2,827,000
	Departures	4.9	102,830	508,000	1,448,000
IAD Subtotal		7.4	202,530	1,500,000	4,275,000
Total		3.1	636,406	1,981,000	5,647,000

† Using $2.85 per gallon of fuel

Table 2 provides a comparison of the modeled fuel consumption savings from this post-implementation analysis with the predicted modeled fuel consumption savings from the Study Team and D&I Team. A positive number represents a savings.

Table 2. Modeled Fuel Consumption Savings Comparison to Predicted Savings

Airport	Operation	Annualized Modeled Fuel Consumption Savings from Baseline (Million Gallons)		
		Study Team Analysis	D&I Team Analysis	Post-Implementation Analysis
BWI	Arrivals	0.50	0.44	0.34
	Departures	0.06	0.06	-0.18
BWI Subtotal		0.57	0.50	0.16
DCA	Arrivals	0.71	0.70	0.58
	Departures	-	0.01	-0.26
BWI Subtotal		0.71	0.71	0.32
IAD	Arrivals	0.94	0.54	0.99
	Departures	0.06	0.38	0.51
IAD Subtotal		1.00	0.92	1.50
Total		2.28	2.14	1.98

The total modeled fuel consumption benefit in the post-implementation analysis is slightly less than predicted by the Study and D&I Teams. This is mainly caused by an unexpected increase in modeled fuel consumption for BWI and DCA departures. However, this increase was likely caused by changes not related to the Metroplex implementation, such as changes in climb rates and cruise altitudes.

Traffic flow management metrics did not experience much change between the pre- and post-implementation data sets. Specifically:

- Airport arrival rates did not change substantially
- Maximum throughput rates did not change. However, minor changes in the amount of time near maximum throughput occurred, and appear to be correlated to the increase or decrease in traffic at each airport
- The use of MIT restrictions temporarily increased after implementations, particularly after the first implementation in 2012, but returned to pre-implementation levels shortly afterwards
- Delay changes were small.

Additional benefits beyond flight efficiency and traffic flow management metrics have also been observed in the data or reported by the affected air traffic facilities, including:

- Segregation of procedures
- Improved en route connectivity
- Reduction in controller pilot transmissions.
  - Shifted responsibility for airspace above the Hagerstown Regional Airport (HGR) to a Terminal Radar Approach Control (TRACON) facility provided the appropriate level of service for the airport and reduced complexity for the overlying en route facility
- More predictable and repeatable flight paths.

5.1 BWI Findings

BWI arrivals had an overall savings in fuel consumption, driven by arrivals from the south. Figure 7 shows the modeled fuel, distance, and time flown savings by direction for BWI arrivals.

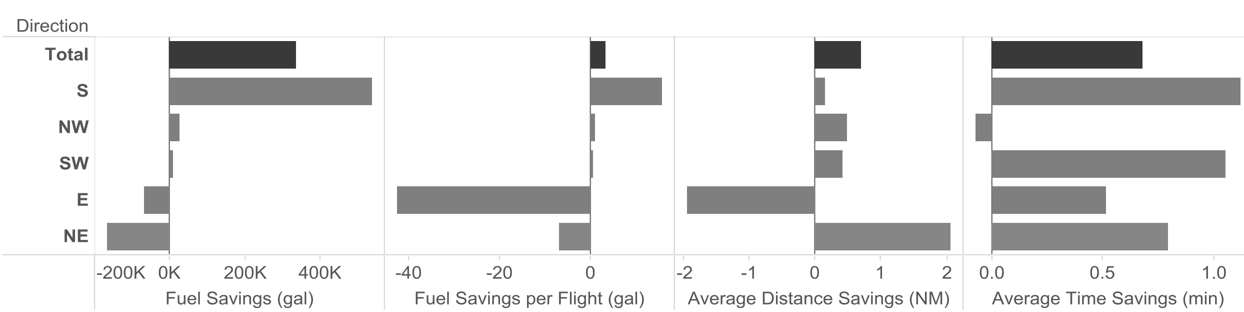

Figure 7. BWI Arrival Metrics

Fuel consumption was essentially unchanged for arrivals from the northwest and southwest. Northwest arrivals showed savings in distance flown, while southwest arrivals had savings in both distance and time flown.

The northeast and east arrivals both showed an increase in modeled fuel consumption despite a decrease in time flown. The change in fuel per flight for east arrivals was particularly high, however they accounted for only a small portion of the arrivals into BWI. The increase in costs for these directions primarily affected flights from nearby airports, where the measured modeled fuel consumption included the departure portion of the flight, which had shallower climbs in the post-implementation data set. It is likely that this change was a result of evolving airline practices rather than the Metroplex project.

In addition to time and distance savings from most directions, there was also a decrease in distance flown in level flight for BWI arrivals, particularly from the northwest, as shown in Figure 8.

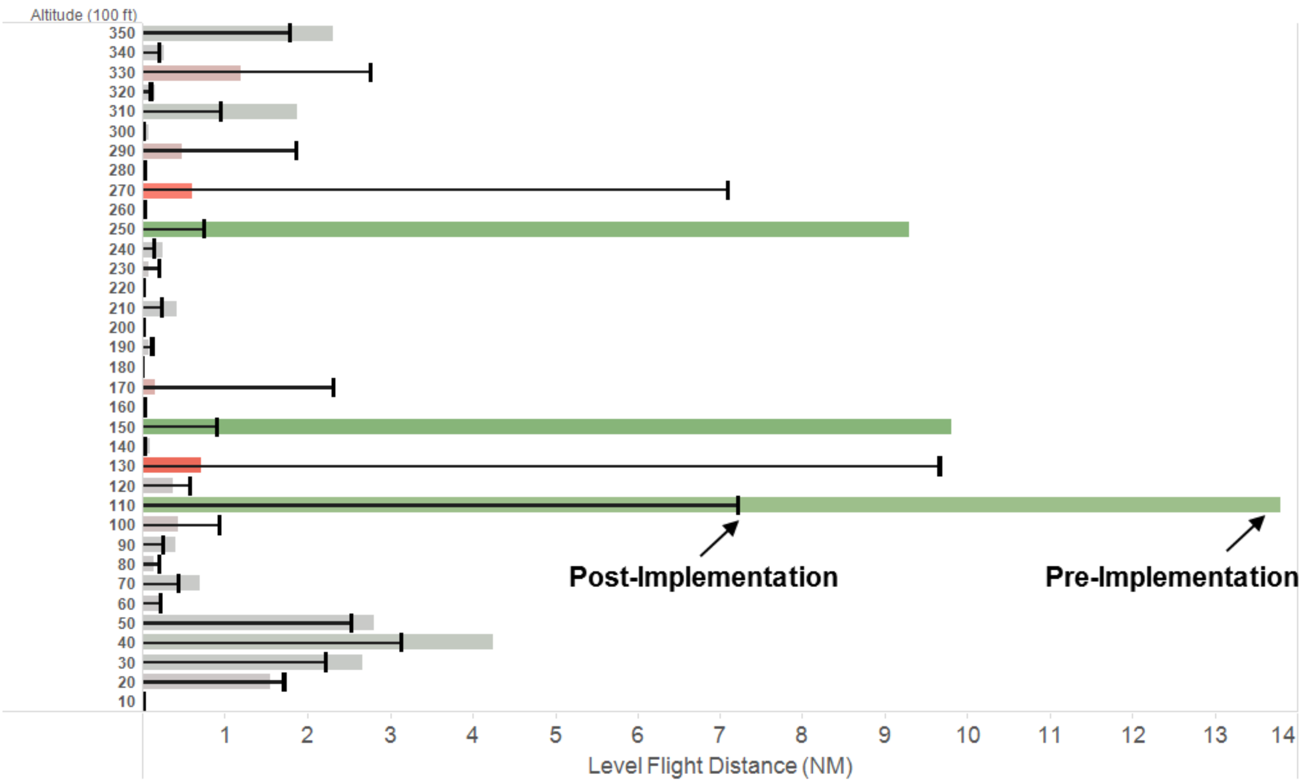

Figure 8. Average Level Flight for BWI Northwest Arrivals

Average level flight for BWI northwest arrivals decreased at 11,000 and 15,000 feet, but increased at 13,000 feet. Additionally, level flight at Flight Level 250 (FL250) was shifted up to FL270.

BWI departures had an overall increase in modeled fuel consumption despite a decrease in distance and time flown. One explanation for the increase in modeled fuel consumption is the shallower climbs and lower cruise altitudes in the post-implementation data set. These changes were not a stated objective of the Metroplex project and are not due to restriction on the procedure or changes in Letters of Agreement among the relevant facilities. Therefore, it is likely these changes are a result of evolving airline practices rather than the Metroplex project. Figure 9 shows the modeled fuel, distance, and time flown savings by direction for BWI departures.

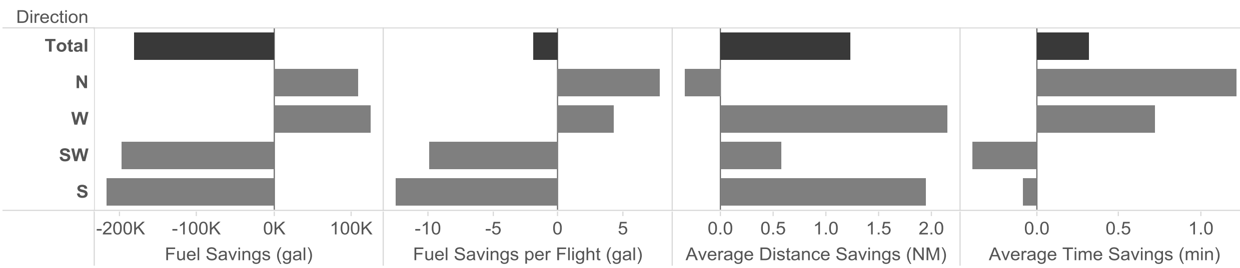

Figure 9. BWI Departure Metrics

The west and north departures experienced savings in modeled fuel consumption, but the increase in modeled fuel consumption for southwest and south departures caused an overall fuel consumption increase for BWI departures.

West departures saved both distance and time flown, while north departures showed a savings in time flown but an increase in distance flown. Despite a distance savings, the south and southwest departures showed a fuel cost and increase in time.

Additional observed differences at BWI between the pre- and post-implementation data sets included:

- High throughput rates occurred less often, likely due to an 11% decrease in traffic
- Small reductions in block delay and arrival delay
- The use of MIT restrictions at BWI spiked after the implementation of the FRDMM, TRUPS, and GIBBZ procedures at DCA and IAD, but returned to previous levels within two months.

5.2 DCA Findings

DCA arrivals showed an overall savings in modeled fuel consumption due to savings from the northwest and southwest. Figure 10 shows the modeled fuel, distance, and time flown savings by direction for DCA arrivals.

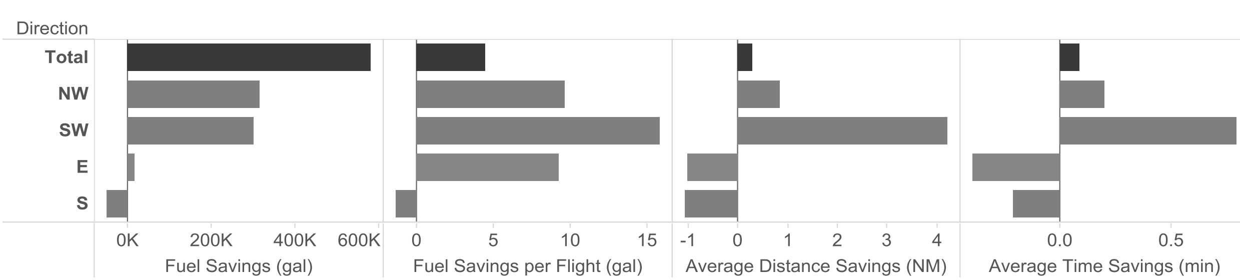

Figure 10. DCA Arrival Metrics

Arrivals from the south had a slight increase in modeled fuel consumption due to distance and time flown increases, despite reductions in level flight. East arrivals showed a decrease in modeled fuel consumption per flight, however there were only a small number of operations and had a minimal impact on the overall results.

Fuel consumption savings from the northwest and southwest were due to reductions in level flight, distance, and time flown. Figure 11 shows the average distance in level flight below top of descent for DCA northwest arrivals for the pre- and post-implementation data sets. The most significant decrease in level flight occurred at 15,000 feet.

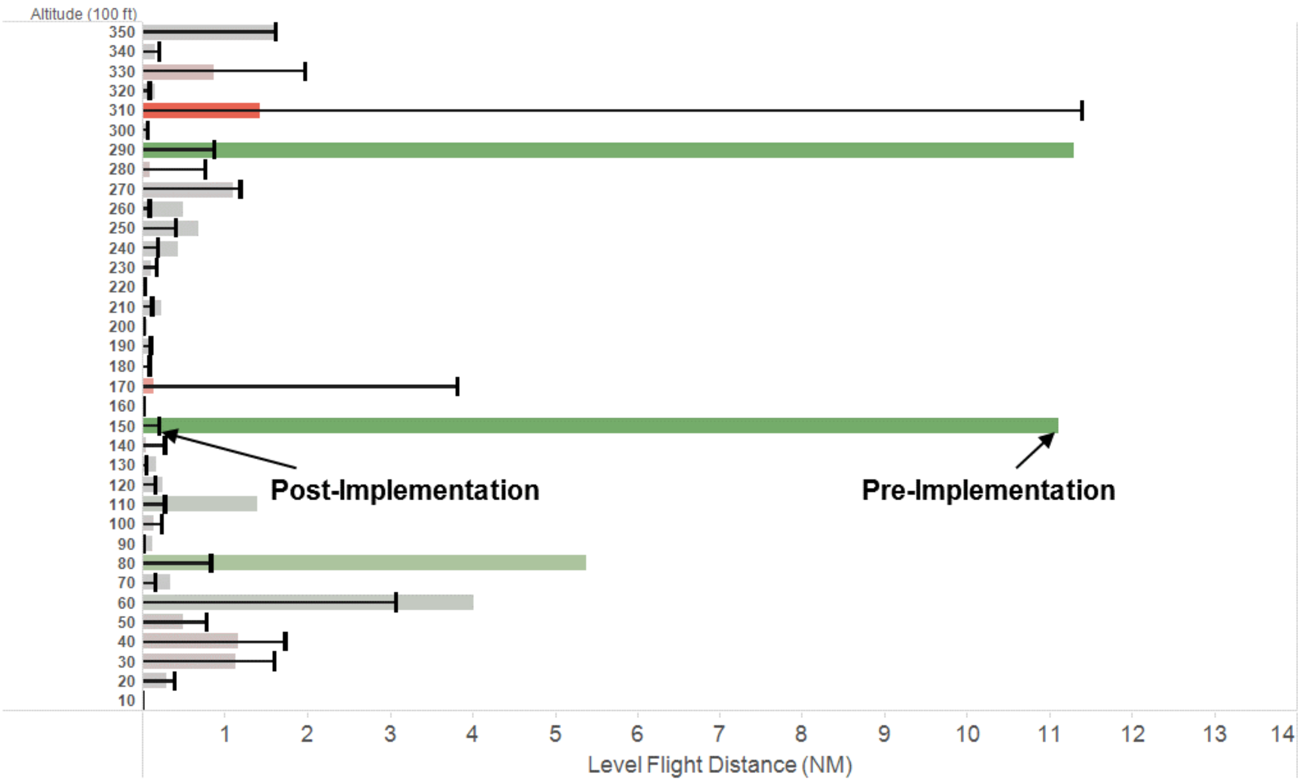

Figure 11. Average Level Flight for DCA Northwest Arrivals

Arrivals from the northwest had the most level flight savings of any direction at DCA. Arrivals from the southwest also experienced significant level flight savings. Arrivals from the east experienced minimal level flight savings.

DCA departures had an increase in modeled fuel consumption in the post-implementation data set, despite distance and time savings in each direction. Similar to BWI, the increase in modeled fuel consumption was primarily due to shallower climbs and lower cruise altitudes in the post-implementation data set, likely a result of evolving airline practices rather than the Metroplex project. Figure 12 shows the modeled fuel, distance, and time flown savings by direction for DCA departures.

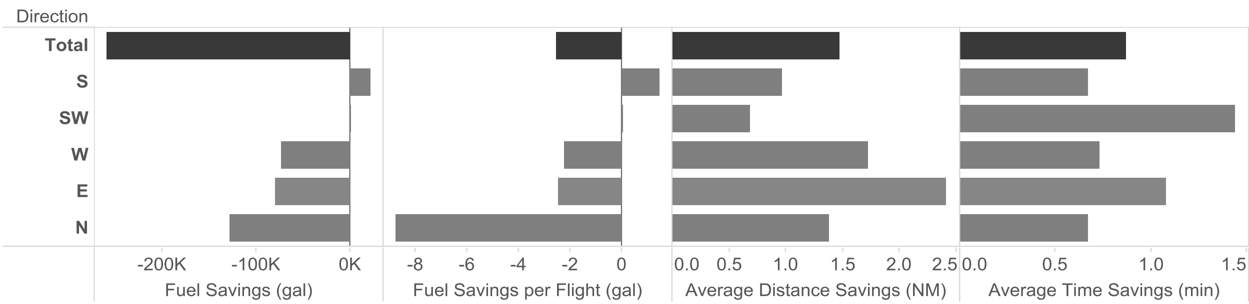

Figure 12. DCA Departure Metrics

Only departures to the south showed a modeled fuel consumption savings. Departures to the west, east, and north all showed an increase in modeled fuel consumption. Departures to the southwest saw no noticeable change, however these results may be influenced by the descent phase of flight for CLT arrivals, which fell within the 300 NM radius.

Additional observed differences at DCA between the pre- and post-implementation data sets included:

- Peak throughput at DCA was similar, but the amount of time spent near peak rates increased slightly after Metroplex, likely due to a 4% increase in operations
- Delays were small and saw little change, even with increased traffic
- Mile-in-Trail (MIT) restrictions increased after implementations due to planned traffic management initiatives (TMIs), but returned to lower levels shortly afterwards
- There was a slight increase in vectoring on good weather days.

5.3 IAD Findings

IAD arrivals had a modeled fuel consumption savings of almost one million gallons of fuel annually. The majority of these savings came from arrivals from the northeast, and were due primarily to a decrease in distance and time flown. These savings include benefits realized from post-implementations amendments on the HYPER and MAPEL arrival procedures.

Figure 13 shows the modeled fuel, distance, and time flown savings by direction for IAD arrivals.

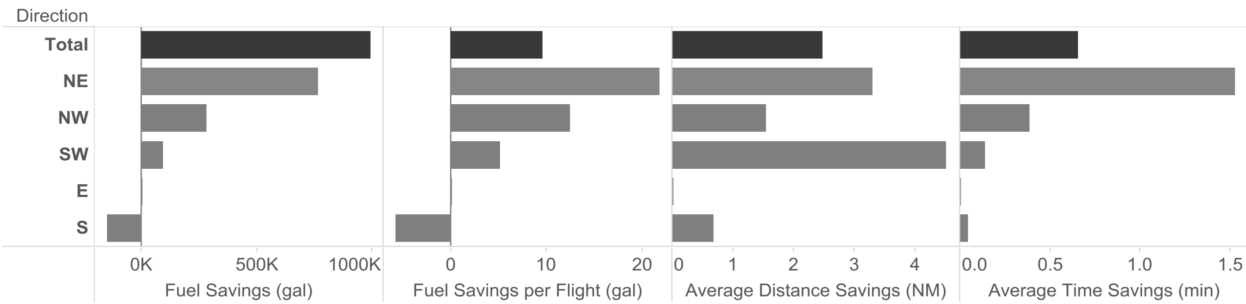

Figure 13. IAD Arrival Metrics

Modeled fuel savings also occurred on northwest and southwest arrivals due to level flight, distance, and time flown savings. Despite small level flight, distance, and time flown savings, arrivals from the south showed a fuel consumption increase, which may be explained by lower cruise altitudes in the post-implementation data set. Similar to BWI and IAD, this increase is likely a result of evolving airline practices rather than the Metroplex project.

Figure 14 shows the average distance in level flight for IAD northwest arrivals.

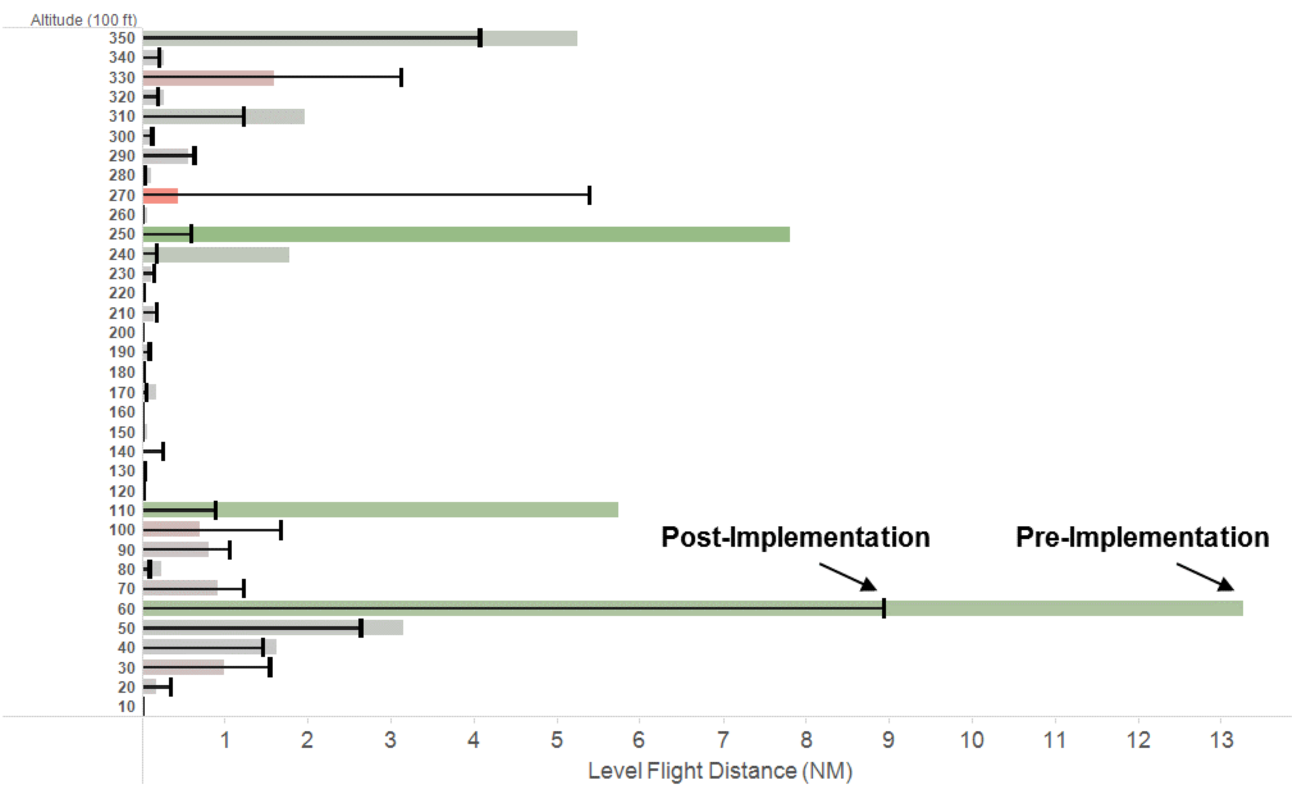

Figure 14. Average Level Flight for IAD Northwest Arrivals

Figure 15 shows the differences in modeled fuel, distance, and time flown by direction for IAD departures. Overall, IAD departures experienced a decrease in modeled fuel consumption due to savings on departures to the west, east, and south. An increase in modeled fuel consumption was observed for departures to the southwest and north. Distance and time flown savings were seen for departures in all directions, but a decrease in climb rates and cruise altitudes, likely not related to the Metroplex implementation, resulted in an increase in modeled fuel consumption for departures to the southwest and north.

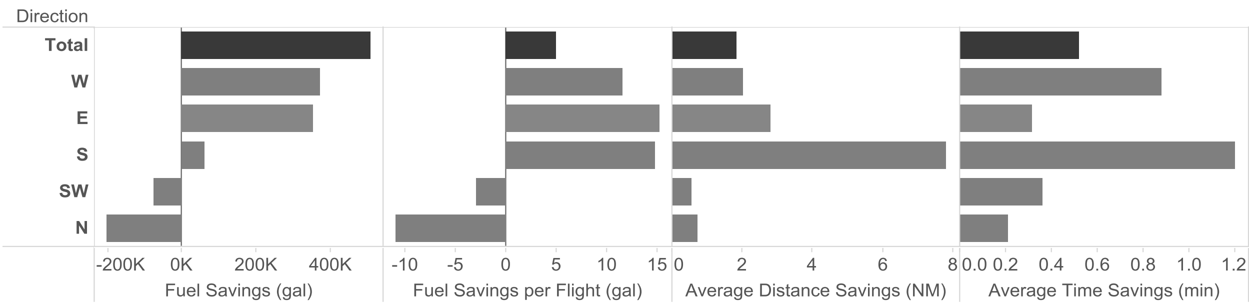

Figure 15. IAD Departure Metrics

Additional observed differences at IAD between the pre- and post-implementation data sets included:

- High throughput rates occurred less often, likely due to an 18% decrease in traffic
- Decrease in en route arrival vectoring
- MIT restrictions increased after the initial GIBBZ STAR implementation due to planned TMIs, but resumed to earlier levels within a month.

6 Post-Implementation Amendments

As the Washington DC air traffic facilities gained experience with the new operations, adjustments were made to the operations at BWI, DCA, IAD, and other satellite airports, including published adjustments to the original procedures. Procedure amendments were scheduled across several charting cycles from June of 2013 through March of 2016. The two largest post-implementation modifications were:

- **Replacing the IAD GRAVZ RNAV STAR and the FSTER conventional STAR with the MAPEL RNAV STAR and the PRIVO conventional STAR**. These procedures were amended to avoid Prohibited Area 40 (P-40) when it was expanded due to Temporary Flight Restrictions (TFRs). The new procedures also satisfy national security concerns regarding the trajectories of the aircraft, which required intensive monitoring by personnel at the National Capital Region Coordination Center (NCRCC). Additionally, the MAPEL and PRIVO STARs provided more direct routing to IAD, saving approximately 10 NM of flying distance. These changes required airspace adjustments, including the transfer of airspace from Cleveland Air Route Traffic Control Center (ARTCC) (ZOB) to New York ARTCC (ZNY) and from Washington ARTCC (ZDC) to ZNY and Potomac TRACON (PCT). The amended airspace and procedures were implemented on August 20, 2015, and therefore influence the flight efficiency metrics derived from the post-implementation data sample.

- **The BWI RAVNN and DCA CAPSS STARs were modified to increase separation between the two procedures**. These arrival procedures were initially designed as stacked OPDs, but were amended to provide both vertical and lateral separation. In the original design, a loss of separation was possible even if aircraft met the published altitude restrictions on both procedures. In addition to deconflicting the procedures, the RAVNN STAR was modified to provide a more direct routing. The amendments also modified altitude constraints on the CAPSS STAR near the start of the runway transition legs to enable a more optimal descent and earlier turn to the downwind. These amendments were implemented on December 10, 2015, and were not included in the flight efficiency metrics.

7 Conclusions

This post-implementation analysis compared BWI, DCA, and IAD airport operations in the months after the Washington DC Metroplex final implementation in 2015 to a similar period from 2011. The extrapolated annual fuel consumption benefit is estimated at 2.0 million gallons for operators at BWI, DCA, and IAD. This value is slightly less than the benefits predicted in the Study Team analysis and the D&I Team analysis. The primary driver of the fuel consumption benefit is the reduction of level flight, distance, and time flown for arrivals.

Additional benefits beyond individual flight efficiency have also been observed in the data or reported by the affected air traffic facilities, including:

- Segregation of procedures
- Improved en route connectivity
- Reduced controller/pilot transmissions
- Reduced complexity for pilots and controllers
- More predictable and repeatable flight paths
- No negative traffic flow management impacts were detected.

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Appendix B Glossary

Acronym	Definition
ARTCC	Air Route Traffic Control Center
ASPM	Aviation System Performance Metrics
ATC	Air Traffic Control
BADA	Base of Aircraft Data
BWI	Baltimore Washington International Airport
CAASD	Center for Advanced Aviation System Development
D&I	Design and Implementation
DCA	Ronald Reagan National Airport
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FL	Flight Level
FRZ	Flight Restricted Zone
HGR	Hagerstown Regional Airport
IAD	Washington-Dulles International Airport
LGA	LaGuardia Airport
MIT	Miles-in-Trail
MITRE	The MITRE Corporation
NAS	National Airspace System
NCRCC	National Capital Region Coordination Center
NextGen	Next Generation Air Transportation System
NM	Nautical Mile/s
OPD	Optimized Profile Descent
PCT	Potomac TRACON
PBN	Performance-Based Navigation
RNAV	Area Navigation
SID	Standard Instrument Departure
STAR	Standard Terminal Arrival
SWAP	Severe Weather Avoidance Plan
TFR	Temporary Flight Restrictions
TMI	Traffic Management Initiative

Acronym	**Definition**
TRACON	Terminal Radar Approach Control
ZDC	Washington ARTCC
ZNY	New York ARTCC
ZOB	Cleveland ARTCC

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