Project Report
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2015 Operational Observation of CoSPA and Traffic Flow Impact

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16. Abstract

This technical report summarizes the operational observations recorded by MIT Lincoln Laboratory (MIT LL) aviation subject matter experts during the period 13 April to 31 October 2015. Three separate field observations were conducted over four convective weather days across the eastern National Airspace System (NAS) with visits to five separate FAA facilities and five different airline operation centers. Observations of strategic management planning and decision making were documented during these visits. Specifically noted were the utilization of the deterministic convective weather forecasting model, CoSPA, and a newly developed decision support application, Traffic Flow Impact (TFI). These field evaluations were supported via the FAA AJM-334 CoSPA program.

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EXECUTIVE SUMMARY

This technical report summarizes the operational observations recorded by MIT Lincoln Laboratory (MIT LL) aviation subject matter experts during the period 13 April to 31 October 2015. Three separate field observations were conducted over four convective weather days across the eastern National Airspace System (NAS) with visits to five separate FAA facilities and five different airline operation centers. Observations of strategic management planning and decision making were documented during these visits. Specifically noted were the utilization of the deterministic convective weather forecasting model, CoSPA, and a newly developed decision support application, Traffic Flow Impact (TFI). These field evaluations were supported via the FAA AJM-334 CoSPA program.

TFI was developed to address a current shortfall in strategic planning by providing explicit translation of convective weather forecasts into resource constraints for traffic managers. Without explicit translation there is a lack of an operationally relevant methodology to quantify weather forecast resource impact and overall forecast performance. Successful strategic planning also relies on the experience of traffic managers involved in Traffic Management Initiative (TMI) planning. MIT LL observers have documented a decrease in experienced traffic managers across key east coast facilities and noted that more than sixty-percent of current traffic mangers have five or fewer years at their current position. This lack of experience has led to breakdowns in the inter/intra-facility communication and coordination protocol, as well as difficulty in maintaining awareness of key issues in convective weather management for adjacent Air Traffic Control (ATC) facilities. Therefore, a wide and often divergent range of opinions and goals from air traffic management and airlines must somehow be melded into a plan of action on days when thunderstorms constrain capacity across the NAS. Without shared objective forecasts of weather impacts and estimates of decision risk, there is little common ground upon which to base discussions about the best plan of action that addresses the different legitimate concerns of stakeholders.

The observations, benefits, and comments collected from the air traffic management community during the 2015 convective season are briefly summarized below. A full description, including detailed operational benefit case studies and the results from a season-end survey, are explained in the body of this report.

- Over 300 hours of observations and 144 separate overall traffic management benefits (82 specific to TFI) were documented during the four in situ observation days.
- Evaluation results of TFI use were encouragingly positive considering limited scope, exposure, and the fact that 2015 was the first convective season the collaborative decision-making community was able to view the decision support application.

- Traffic managers immediately understood the translational concept of TFI and were able to envision how this application would be incorporated into their decision-making during severe weather events.

- The ability of TFI to create a general situational awareness in the traffic management unit was widely documented.

- Improved Airspace Flow Program (AFP) execution and management were beneficial to both the FAA and airlines, specifically aiding in go/no-go decisions as well as determining the onset, duration and intensity of the convective event.

- Users displayed an immediate aptitude for using the TFI product which allowed them to quickly envision ways to adapt the application to their everyday use.

The top user suggestions and/or recommendations are:

- Provide TFI regions that map directly to current standardized FAA AFPs, more TFI Flow Constrained Areas (FCAs) to cover more airspace, **and** actual traffic flow rate suggestions that can be used by traffic management to develop more focused and efficient strategic initiatives.

- Provide CoSPA and other decision support products, such as TFI, on the stand-alone displays currently hosting CIWS in FAA and airline facilities or on any platform that can provide stand-alone access to the products.

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We wish to extend our sincere gratitude to the following people.

- To Thomas Webster, CoSPA Program Lead, for supporting this program and for his guidance and enthusiasm.
- To Anthony Tisdall, Lead of System Operations at ATCSCC, for allowing MIT LL observers access to the operations floor at the Command Center and his very knowledgeable staff of traffic management personnel.
- To the TMOs at ZBW, ZOB, ZNY, and ZDC for allowing access to the facilities and the TMU staff.
- To the TMU staff at ZBW, ZOB, ZNY, and ZDC for giving generously of their time and expertise to help us understand and document the decision making process.
- To the management at Delta, JetBlue, American, United, and Southwest Airlines, for allowing MIT LL observers into their facilities and providing access to their staff. Also to the air traffic control staff at these airlines for sharing their insights into the decision making process.
- To the other MIT LL observers (Darin Meyer, Brad Crowe, Richard Ferris, Fulvio Fabrizi, Peter Erickson, Kim Calden, and Ngaire Underhill) whose many long hours of documentation made this report possible.

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1. INTRODUCTION

CoSPA produces 0- to 8-hour deterministic forecasts of Vertically Integrated Liquid water (VIL) and Echo Tops (ET) for air traffic managers. CoSPA blends short-lead heuristic forecasts from the Corridor Integrated Weather System (CIWS) with longer-lead forecasts from the National Oceanic and Atmospheric Administration (NOAA) High Resolution Rapid Refresh (HRRR) numerical model. CoSPA represents an FAA-led collaboration among three laboratories: the Massachusetts Institute of Technology Lincoln Laboratory (MIT LL), the National Center for Atmospheric Research (NCAR), and the NOAA Global Systems Division (GSD).

The 2015 CoSPA Demonstration was conducted from 13 April to 31 October 2015. As part of the demonstration, five FAA facilities and five commercial airlines were visited by MIT LL observers on several occasions. Targeted field observations were conducted by MIT LL observers to gather information on how the CoSPA weather forecast was used in operations, to obtain feedback on new capabilities, and to collect comments for improvement. During the field demonstration, the 0- to 8-hour CoSPA VIL and ET forecasts were available via web to all registered users through the dedicated website http://cospa.wx.ll.mit.edu. The website reached over 10 million specific product hits (i.e., VIL, ET, Lightning, etc.) during the demonstration period. The system uptime for CoSPA during the demonstration was approximately 95%, which was 3% lower than 2014 due to a major failure of critical hardware at MIT LL. This failure was caused by damage to an Uninterruptible Power Supply in the computer room which resulted in a total loss of CIWS and CoSPA products for a period of five days. Details on the web usage and uptimes are provided in Appendix A.

1.1 BACKGROUND AND MOTIVATION

The 0- to 8-hour forecast guidance provided by CoSPA addresses key weather impact factors, including intensity of storms, location, scale, permeability[1], and timing (onset, duration, clearing of impact). These factors often determine the type of mitigation needed to offset the adverse effects of weather and can guide planners in the implementation of strategic traffic management initiatives (TMIs) such as:

- Playbook re-routes,
- Ground Delay Programs (GDPs), and

[1] Permeability is the degree to which airspace that appears to be impacted by convective weather actually is usable by air traffic. Key elements of permeability are the spatial distribution of weather intensity and storm echo tops.

- Flow Constrained Areas (FCAs) associated with Airspace Flow Programs (AFPs).

The need for 2- to 8-hour storm forecasts for aviation decision support arises from two key decisions that need to be made; either aircraft must be held on the ground before they depart their origin airport, or they must be assigned a different route which entails a longer flight distance. When making these decisions, two important characteristics of flight planning must be considered:

- Airlines are expected to file their flight plans 60 minutes before departure. Airline dispatchers typically begin to plan their flight routes two to four hours prior to departure, especially when weather impacts are expected.

- The overall distribution of domestic flight times for many key airports is such that if significant arrival demand reductions need to be accomplished (e.g., 50% reductions), a number of long duration flights (>4 hours) must be held on the ground.

Figure 1 shows flight duration (wheels up to wheels down) for all flights (except general aviation) in the US National Airspace System (NAS) for one day in 2014. Most flights are one to two hours in duration, so the weather impact prediction horizon associated with holding flights at their origin airport would be 2.5 to 4 hours, including 1.5 to 2 hours of pre-flight planning. If one assumes a weather impact on airspace capacity duration of about two to four hours, then airline dispatchers and FAA traffic managers need weather forecasts extending out to 4.5 to 8 hours to specify both the start and expected end of a severe-constraint TMI.

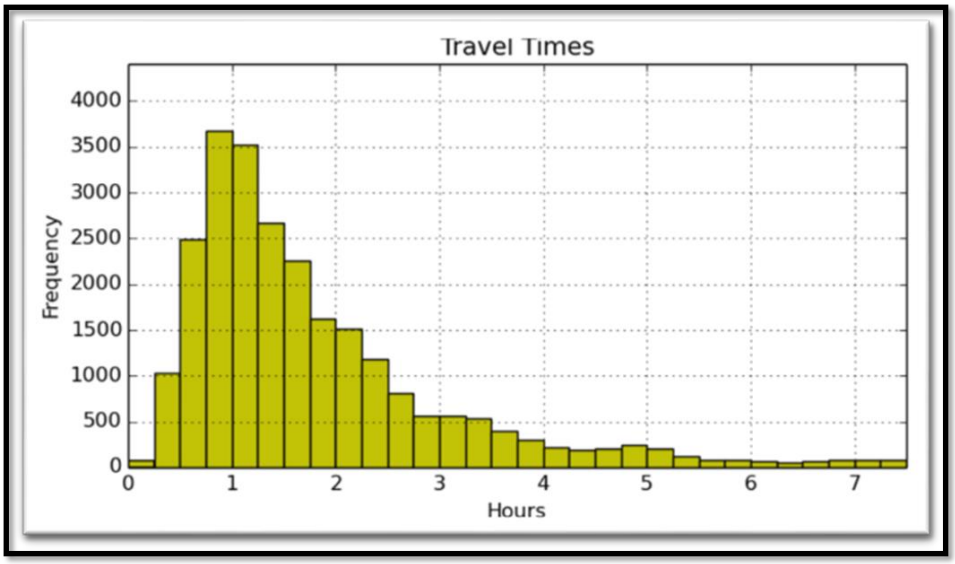

Figure 1. Flight duration (wheels up to wheels down) for all flights (except General Aviation) in the National Airspace System on one day in 2014.

The area of greatest concern for improved strategic convective weather decision support is the northeast portion of the NAS due to the very high density of traffic in enroute airspace. The weather accounts for nearly 70% of the delay in the NAS, and convective weather accounts for 60% of these weather delays (Figure 2a) [1]. There is also a high demand-to-capacity ratio for major airports (especially John F. Kennedy International Airport (JFK), LaGuardia Airport (LGA), and Newark International Airport (EWR), and the frequency of major impacts on operations as measured by arrival delays, deviations, airborne holding, and excessive taxi out delays (Figure 2b).

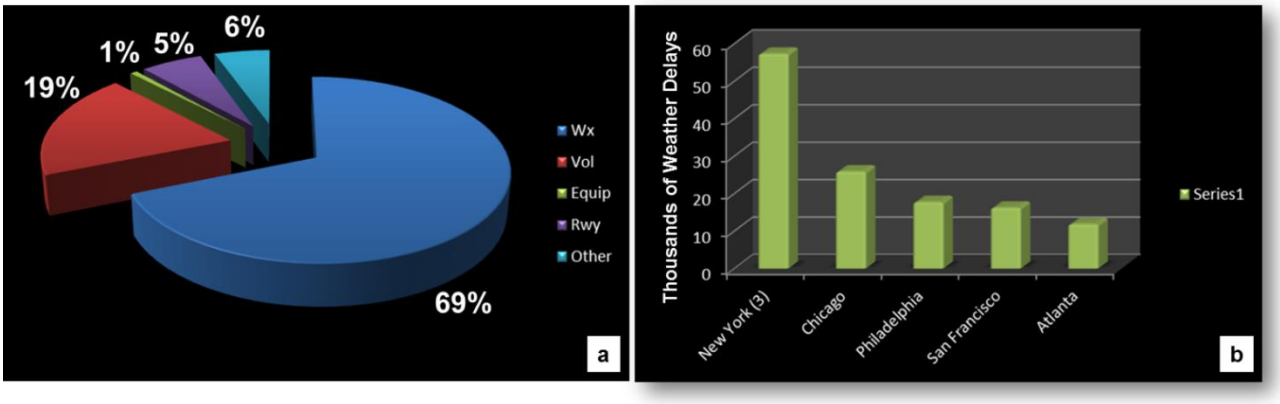

Figure 2. 2008-2014 (a) average percent delays by cause and (b) top seven weather delayed airports in 2014 derived from the FAA Operations Network (OPSNET).

Figure 3 provides a breakdown of delays by month for each of the three individual major NY terminals, JFK, LGA, and EWR. The majority of those individual weather delays occur during the convective season in the Northeast spanning from late May through early September.

Weather impacts in this region are often handled by traffic initiatives known as Severe Weather Avoidance Planning (SWAP). SWAP requires both strategic and tactical initiatives in order to manage throughput in and around the New York (NY) metroplex. Northeast SWAPs are required on roughly 80 days each convective season (Figure 4).

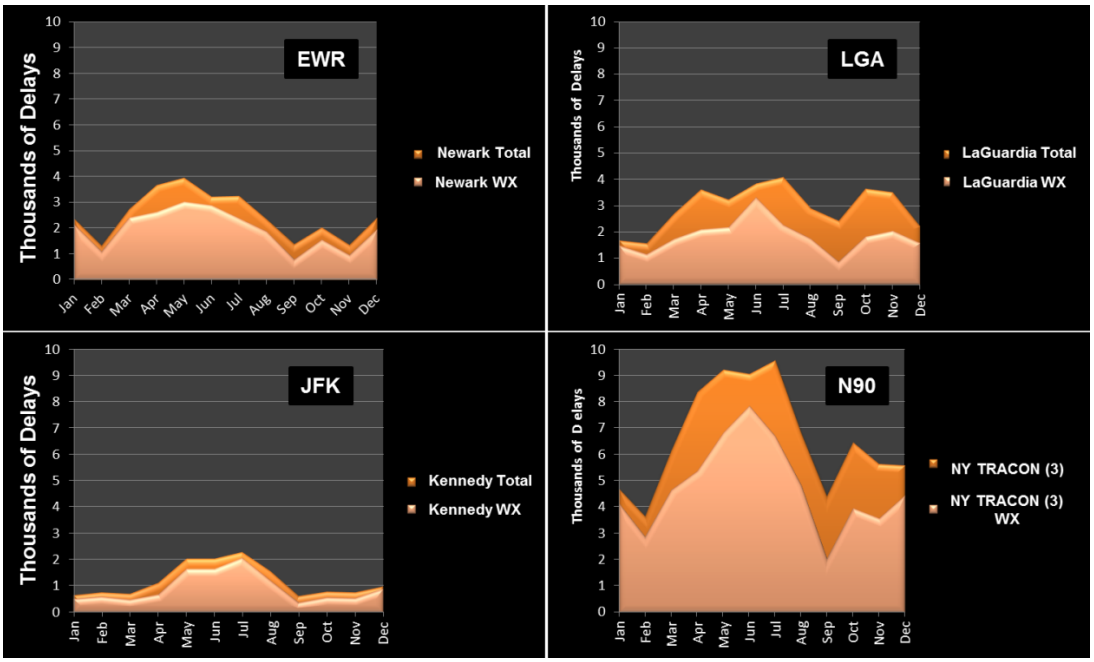

Figure 3. 2013 Delays for NY TRACON (N90) terminals.

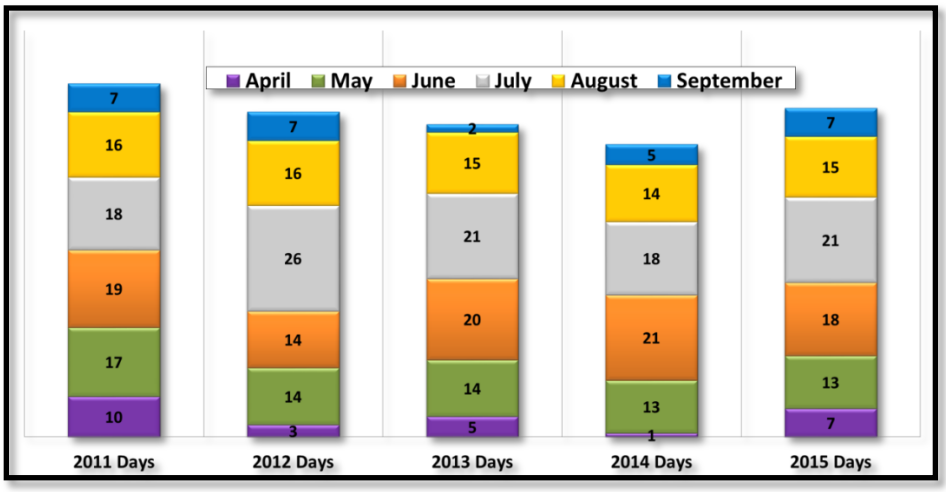

Figure 4. Monthly Severe Weather Avoidance Plan (SWAP) days (1 April through 30 September) spanning the most recent five years[2].

[2] SWAP 2015 Results-Basic Operational Data-Air Traffic System Control Center (ATCSCC)-October 2015.

Given the importance of convective forecasts to air traffic management in the NY Metroplex, MIT LL subject matter experts conducted field observations on days when storms were forecast to develop across the eastern United States and potentially create an imbalance between demand and the usable capacity for enroute and terminal airspace in the northeast United States. The MIT LL observation team was able to gather data from three separate convective events covering four days (13-14 July, 3 August, and 20 August). MIT LL observers visited four FAA Air Route Traffic Control Centers (ARTCC) and the Air Traffic Control System Command Center (ATCSCC), considered the "main players" in the strategic planning process. The ARTCCs included Boston Center (ZBW), Washington DC Center (ZDC), New York Center (ZNY), and Cleveland Center (ZOB). Five airlines (Delta, American, United, Southwest and JetBlue) also participated in the observations.

The main objectives of the 2015 field observation study were to:

- Train and evaluate a new decision support application: Traffic Flow Impact (TFI) [2]
- Observe and document usage of the TFI application specifically noting:
    - How/if the application is used in strategic planning of AFPs
    - If the addition of Forecast Confidence fulfills the user requested need for accuracy scoring of the 2- to 8-hour deterministic forecast
- Determine if and how the CoSPA forecast is effectively being used in strategic Traffic Management Initiative (TMI) decision-making
- Document comments, criticisms, and concerns for CoSPA to provide insights on how the application could be improved for decision support
- Investigate and document user preferences that pertain to current CoSPA capabilities and performance, such as update rate, forecast interval, etc.
- Document and gain a more in-depth understanding of the decision-making process currently employed within traffic management in order to design and assess potential CoSPA adaptations and improvements
- Document suggestions and ideas to help identify unmet needs and define requirements for enhancements to the 2- to 8-hour deterministic forecast

In addition to the focused observations, refresher training for existing personnel and training of new Federal Aviation Administration (FAA) traffic managers was conducted.

1.2 CURRENT SHORTFALLS IN STRATEGIC PLANNING

The lack of an explicit translation of weather forecasts into capacity resource constraints is a shortfall in the current weather information available to air traffic managers for strategic traffic flow management. There are several consequences of this shortfall. First, without an explicit translation there is a lack of an operationally relevant methodology to assess weather forecast resource impact and overall forecast performance. Each participant (e.g., ATCSCC, ARTCC Traffic Manager Unit (TMU), and Airline Operations Centers) comes to the collaborative strategic planning process with their own set of operational objectives, favorite forecast information, risk tolerance, etc. This wide and often divergent range of opinions and goals must somehow be melded into a plan of action. Without shared objective forecasts of weather impacts and estimates of decision risk, there is little common ground upon which to base discussions about the best plan of action that addresses the different legitimate concerns of stakeholders. Second, the utility of convective weather forecasts is directly related to the quality of decisions and NAS performance outcomes that the forecasts can support. The definition of explicit, validated weather translations provides an objective and operationally relevant measure of truth against which forecasts can be compared. Without translation-based forecast evaluations, it is difficult to determine how much of the operational shortfall in convective weather mitigation is due to poor weather forecasts and how much is the result of poor interpretation and application of forecast information.

1.3 REPORT SCOPE AND OUTLINE

This report provides an overview of the CoSPA and TFI forecast products and documents results in support of the main objectives stated in Section 1.1. Section 2 describes the field observation process and highlights current operational impacts and recent changes in air traffic management related to the strategic planning process. A detailed explanation of observed CoSPA and TFI benefits is provided in Section 3 along with recorded operational examples. Section 4 details user requests and comments, and presents the findings of a small-scale season-end user evaluation. A final summary and outlook on future CoSPA/TFI work is presented in Section 5.

2. FIELD OBSERVATION SUMMARY

2.1 FIELD OBSERVATION PROCESS

Convective multi-day weather forecasts were produced by the MIT LL observation team on a daily basis throughout the summer beginning in April. Each medium range (three- to seven-day) forecast was evaluated in order to determine the potential severity and placement of storms across the NAS to help plan a field observation. When the forecast indicated a potentially impacting convective weather event for the northeast United States, the MIT LL observer assigned to a facility contacted the facility's designated point-of-contact to request permission to visit. MIT LL observers arrived at their respective facility between 1000Z and 1100Z in order to be in position to monitor the preparation for, and participation in, the first Strategic Planning Telecon (SPT) of the day. They remained at the facility until the end of the weather impact; some nights as late as 0030Z. Each observer was at their facility an average of 13 hours each day, totaling approximately 52 hours of observations per facility over the four days and resulting in more than 300 hours of observations gathered across all FAA (ATCSCC, ZBW, ZNY, ZDC, and ZOB) and airline (JetBlue, United, Delta, Southwest, and American) facilities. (Not all airline facilities were visited every observation day.)

Observers resided primarily in the TMU or operations area of the facility in order to gather observations on the use of CoSPA and TFI. Observers answered any questions and performed in-situ training relating to CoSPA, CIWS, and TFI, and answered questions concerning Integrated Terminal Weather System (ITWS), if requested by Air Traffic personnel and meteorologists. Observers also asked air traffic managers how TMI decisions were made, what information was used to support the decisions, and other questions related to the assessment objectives. Questions were asked only when they did not interfere with the TMU's primary mission of traffic management. To ensure consistency across observers and facilities, each observer used a standardized data-entry sheet to record events in which personnel referred to or otherwise interacted with CoSPA or TFI. Entries included the date, time, user, type of interaction, and notes detailing the context or other stakeholders involved. Results are summarized in Section 3 and presented in more detailed tabular form in Appendix B and Appendix D.

Figure 5 provides a representative CoSPA VIL image for each of the four observation days. Each of the days was characterized by widespread storms across the eastern third of the nation which disrupted the daily operations across the NAS to varying degrees; however, the overall weather pattern of each day was very similar. All four days featured large scale frontal features which traversed the northern and eastern United States during the observation periods (Figure 6).

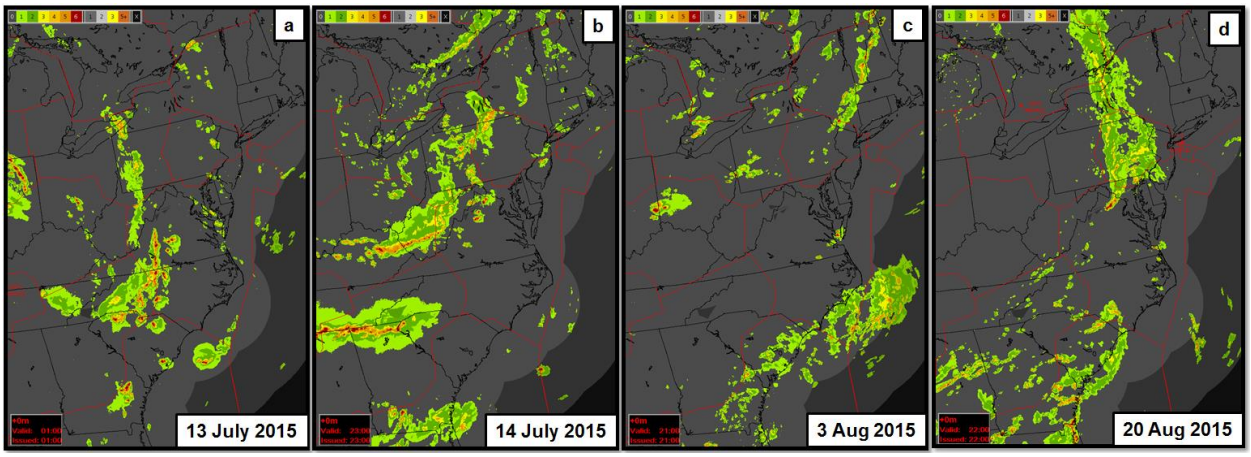

Figure 5. Representative VIL images of each CoSPA observational visit: (a) 13 July, (b) 14 July, (c) 3 August and (d) 20 August 2015.

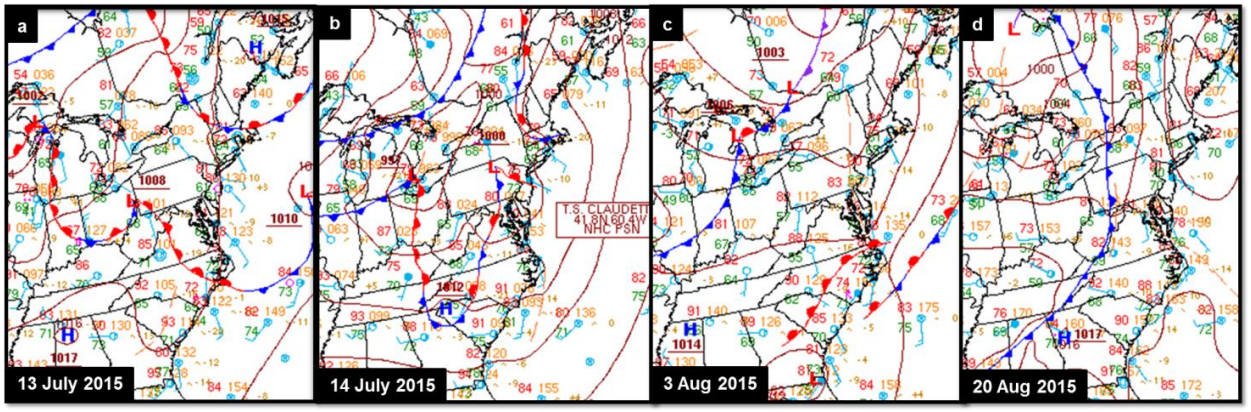

Figure 6. National Weather Service (NWS) 1800 UTC surface pressure and frontal analysis for each observation case day: (a) 13 July, (b) 14 July, (c) 3 August and (d) 20 August 2015.

2.2 OPERATIONAL IMPACTS

Despite the overall similarity of the weather picture during the observational visits, the impact on daily operations across the NAS varied. Table 1 provides a brief assessment of each observation day in relation to Air Traffic Control (ATC) impact in the Northeast region of the NAS.[3]

TABLE 1

Aviation System Performance Metrics (ASPM) Based on Eight Core Airports in the Northeast NAS, Indicating the Severity of the Impact of Thunderstorms on Air Traffic Demand

Northeast Terminal Operations and Delay Statistics						
Day	**Total Operations**	**Cancellations (Departure/Arrival)**	**Diversions**	**Airborne Holding Minutes (Hours)**	**% Completion Rate**	**Airspace Flow Program(s)**
8 June*	8076	309/350	52	3324 (55)	93	OB1/A08
23 June*	7757	633/664	64	2447(41)	86	OB1/A08
13 July	8696	94/96	4	22(0.4)	98	A01/DC4
14 July	8227	438/440	35	3493(58)	90	OB1/A08
3 August	8817	80/83	4	0	98	OB1/A08/JX7
20 August	7601	625/637	10	242(4)	85	OB1/A08
*Not a MIT LL CoSPA Observation Day						

This table also includes two additional convective weather days (8 and 23 June 2015) which are depicted in Figure 7. The two additional days are provided as a baseline for throughput disruption across the NAS in comparison to the four MIT LL observation days. They are considered two of the top most disruptive delay days during the summer of 2015[4].

[3] Data gathered using the FAA Aviation System Performance Metrics (ASPM) ATO Efficiency Report Online (AERO) database.

[4] Based on notes gathered during the End of Season Review (EOSR) on 27-28 Oct 2015; McLean, VA.

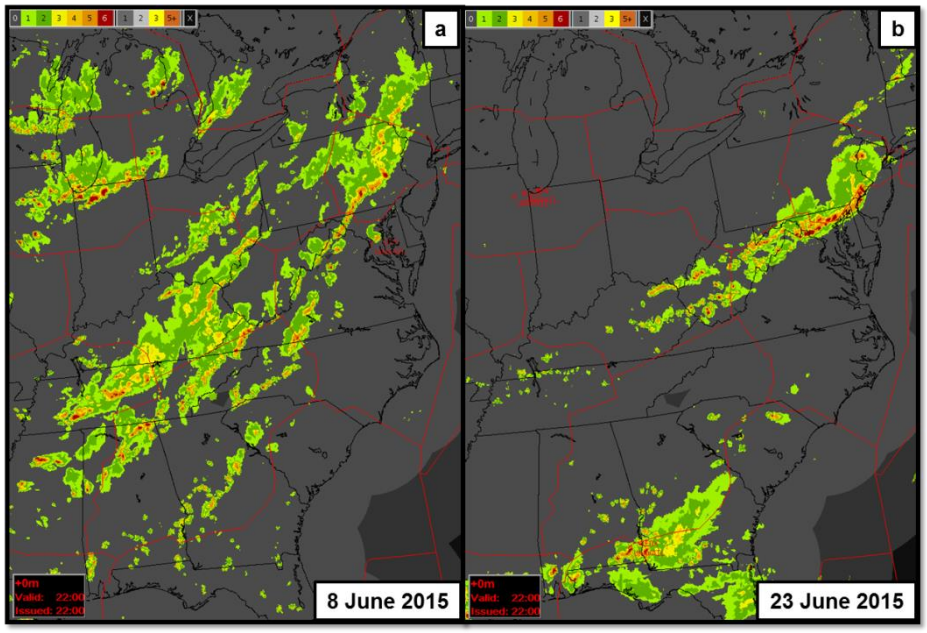

Figure 7. CoSPA VIL images of additional convective weather days on (a) 8 June (a) and (b) 23 June 2015.

TABLE 1 consists of traffic data and delay statistics commonly used by FAA and airline management to gauge daily performance. The Northeast Operational Evolution Partnership[5] (OEP) terminals included in the data are Boston International Airport (BOS), EWR, JFK, LGA, Philadelphia International Airport (PHL), Baltimore Washington International Airport (BWI), Washington Dulles International Airport (IAD), and Reagan National Airport (DCA).

The total operations count includes all arriving and departing aircraft at each of the eight core terminals. Cancellation count includes aircraft from originating terminals (arrivals) and aircraft departing the core airports. Diversion count includes those aircraft that were destined to one of the eight terminals but had to divert to another airport. Airborne holding minutes are characterized in three ways[6]:

1. Flights held within 100 nmi of the airport when the destination airport arrival rate ***was not*** met

2. Flights held within 100 nmi of the airport when the destination airport arrival rate ***was*** met

[5] OEP airports are commercial US airports with significant activity, serve major metropolitan areas, and also serve as hubs for airline operations. More than 70% of passengers move through these airports.
[6] Source: FAA Operations Network (OPSNET).

3. Flights held outside 100 nmi without consideration of the destination airport arrival rate

The Completion Rate is defined by the percentage of scheduled arrivals that were not cancelled, calculated as 100*[1 - Cancelled Arrivals / Number of Scheduled flights]. Cancelled Arrivals are determined the next day using flight plan cancellation messages for ASPM carriers and all other carriers reporting schedule data, and scheduled flights not flown.

It is often difficult to conclude that traffic was disrupted more on one day than another based solely on individual delay statistics. The operational impact statistics do not necessarily indicate when a day was difficult for air traffic managers. It might be that the weather impact was very severe (e.g., solid squall line) but consistent, accurate forecasts by all the major models helped air traffic managers plan effectively. Conversely, other days might have had significant weather impacts, but unreliable forecasts and/or an overall complicated weather pattern (in space and time) resulted in less effective planning. The fact is that delay can be the result of a multitude of different initiatives that exist to manage air traffic, and the complexity of the airspace involved. Severe weather introduces complexity into air traffic management that at times can be difficult to predict. However, statistics like these are used in many post-analysis discussions and forums by the Collaborative Decision-Making community. The statistics in Table 1 provide a comparison to the most challenging convective days in 2015 for managing air traffic across the NAS while quantifying the level of severity of each MIT LL observation day.

2.2.1 Recent Changes in Traffic Management

An important factor in the strategic planning process revolves around the experience of traffic managers and all those involved in strategic TMI planning [3]. MIT LL observers have noted that over the past several years many experienced traffic managers across every facility have been retiring.[7] MIT LL trainers documented the years of traffic management experience during training visits in the spring of 2015. Figure 8 shows the level of experience of 65 traffic managers (Supervisor Traffic Management Coordinators [STMCs] and Traffic Management Coordinators [TMCs]) at the five FAA facilities visited by MIT LL observers.

[7] Based on direct interviews by MIT LL during 2013, 2014 and 2015 CoSPA Observation visits.

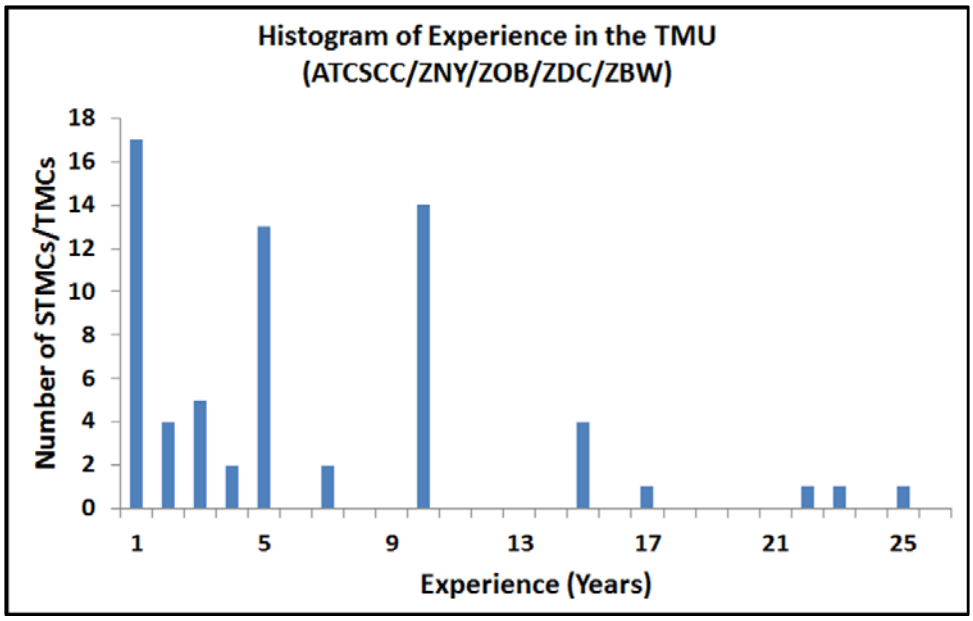

Figure 8. Experience of 65 traffic managers at facilities visited by MIT LL observers during Spring 2015 training.

Trainers also noted the distinction between TMCs and STMCs within the TMU. These retirements are occurring at such a rapid pace that it has been difficult to transfer the accumulated convective weather traffic management knowledge to the incoming managers. The histogram in Figure 8 shows that the majority of managers hold five or fewer years' experience in the position. As a result of this loss in experience, initial observations have documented longer coordination time required in both strategic and tactical planning. This increase in time is often due to the new manager's limited knowledge of re-route options.

A lack of understanding of the inter/intra-facility communication and coordination protocol, as well as awareness of key issues in convective weather management for adjacent ATC facilities, has also been noted at multiple FAA facilities. This breakdown in communication can often slow the planning process. Effective coordination and collaboration are critical in highly congested airspace, as discussed in Davison and Hansman, 2001 [4].

3. OBSERVED OPERATIONAL BENEFITS

3.1 COSPA FORECAST ASSESSMENT

Before going further, it is necessary to clarify some terminology. An Airspace Flow Program (AFP) is a traffic management initiative that identifies constraints in the enroute system, develops a real-time list of flights that are filed into the constrained area, and distributes Estimated Departure Clearance Times (EDCTs) to meter the demand through the area. Flow Constrained Areas (FCAs) are three-dimensional volumes of airspace, along with flight filters and a time interval, used to identify flights. FCAs may be drawn graphically (e.g., around weather), or they may be based on a NAS element such as a VORTAC or navigational aid used by pilots. They are used to evaluate demand on a resource. FCAs may be standardized across all facilities for ease of access and to facilitate coordination. FCAs may also be defined in real-time by users.

The FAA has developed several standard FCAs (e.g., OB1, A05, A08, etc.) that are used to design AFPs for traffic into the Northeast. Air traffic users generally refer to these standard FCAs as AFPs, and the same terminology is used in this report to differentiate standard FAA FCAs (now called AFPs) from TFI FCAs. (TFI FCAs cannot be defined by users or in real time.)

CoSPA's ability to predict large-scale events (e.g., cold fronts) more accurately than individual thunderstorms in the 2- to 8-hour range was observed throughout the 2015 convective season. This skill has been noted every season since CoSPA's inception in 2010. CoSPA's use of the High Resolution Rapid Refresh 3km storm resolving model contributes greatly to this accuracy in the longer-lead forecast range (2- to 8-hour) [5]. The large-scale forecast accuracy displayed by the CoSPA 8-hour forecast is very useful to air traffic managers at the various facilities. Strategic air traffic planning involves movement of large flows of aircraft many hours in the future through the implementation of initiatives such as Playbook re-routes, GDPs and AFPs. The CoSPA 2- to 8-hour forecast allows traffic managers to view how storms may or may not eventually impact large regions of airspace and to assess the need for TMIs. AFP planning, in particular, requires five or more hours of coordination in order to manage West Coast demand expected to traverse impacted airspace in the eastern United States. Key decisions involving weather classification type (line, scattered), timing (onset, duration), scope, and rates of traffic need to be made on aircraft from the West Coast before they take off since it is easier and more efficient to manage demand of aircraft on the ground rather than in the air.

Figure 9 is a plot of (a) the 1500Z CoSPA 8-hour VIL forecast and associated CCFP forecast along with (b) the 2300Z VIL truth on 14 July 2015. A large-scale synoptic low pressure system and cold front moved through the Ohio Valley on this observation day. Many clusters of thunderstorms developed along and ahead of the front by 1500Z and several of the clusters formed into longer lines of convection between 1800Z and 2000Z. The forecast skill displayed in Figure 9 is typical of what was observed throughout the summer for larger-scale convective events. CoSPA was able to capture onset, duration,

and much of the intensity of the storms along with relatively accurate placement of the larger scale lines; most notably the storms that stretched from south-central NY state, into central PA, and through southern WV. CoSPA was able to capture the long, east-to-west line of storms which formed along the southern Tennessee border. The model forecast also indicated that scattered cells would initiate ahead of the main line just west of Washington DC in the area around IAD. Although the location was not exact, CoSPA did indicate that storms would develop west of the major NY terminals (EWR, JFK, and LGA). Storms eventually formed south over coastal NJ, not west of the region along the PA border as depicted in the 8-hour forecast.

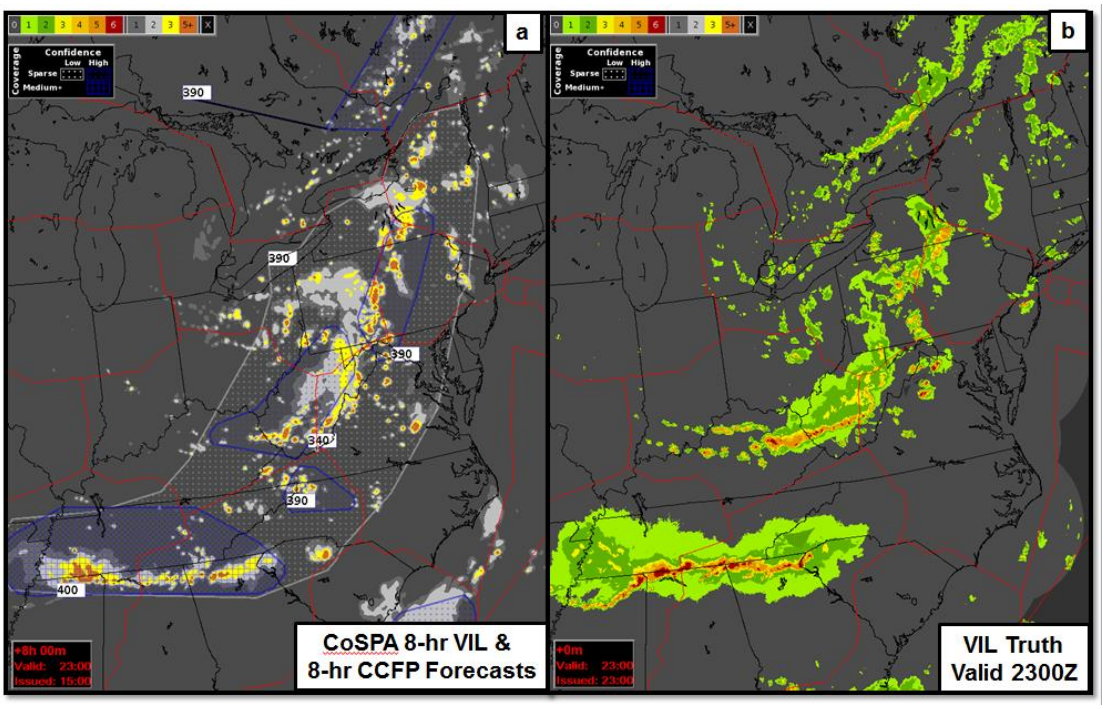

Figure 9. (a) 1500Z CoSPA 8-hour VIL forecast and CCFP forecast overlay valid at 2300Z and (b) the 2300Z VIL truth on 14 July 2015.

CoSPA is often challenged by smaller-scale events and the scattered thunderstorm activity that accompanies this pattern type. Figure 10 displays (a) the 1100Z 8-hour ET forecast and associated CCFP prediction, along with (b) the 1900Z ET truth on 4 August 2015. This day featured a weakening cold front which had lost much of its structure during the previous day. National Weather Service analysis depicted a weak trough in the surface pressure with minimal temperature and wind differences across the boundary. Four key CoSPA deficiencies that have been noted in several similar 2015 cases are:

1. CoSPA forecasts convective initiation later than the actual onset

2. CoSPA under forecasts VIL intensities

3. CoSPA under forecasts Echo Top heights

4. CoSPA under forecasts the duration of event (i.e., convection initiates later than forecast and storms decay earlier than forecast)

The ET truth in Figure 10b shows two intense lines of thunderstorms on 4 August, one in central ME the other in central and eastern MA and NH. Each line developed in the early afternoon and was not captured by the CoSPA forecast earlier in the day. The 8-hour ET forecast shows only scattered storms, of moderate intensity, with ETs near 30kft scattered across ME and 35kft just north of Cape Cod, MA. However, the truth displayed at 1900Z clearly shows long, solid lines of storms with tops averaging 40-45kft across much of the affected region.

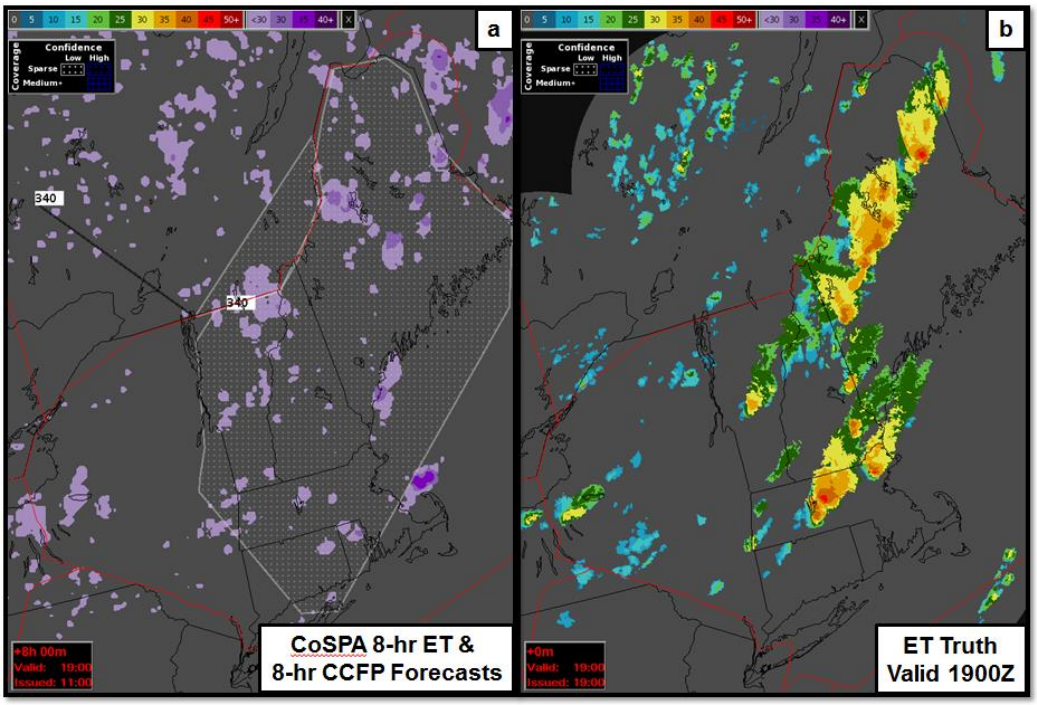

Figure 10. (a) 1100Z CoSPA 8-hour ET forecast and CCFP forecast overlay (b) with the 1900Z valid ET truth on 4 August 2015.

3.2 OBSERVED BENEFITS

Observations recorded during field evaluations were analyzed to identify operational decisions where CoSPA and/or TFI provided a benefit to users. These benefits were divided into 12 categories shown in Table 2.

TABLE 2

Observed CoSPA Benefits Categories

	Key	Benefit Category
Using CoSPA	AFP	**Improved AFP Execution / Management** Assigned when CoSPA used to make AFP Go/No-Go decisions, AFP decisions on start time, stop time, rate, plan modifications, etc.
	COORDINATION	**Enhanced Inter/Intra-Facility Coordination**
	ERP	**Enhanced Reroute Planning** Includes avoiding reroutes by recognizing viability of nominal routes, proactive reroute implementation, and ending reroutes/returning to nominal routes sooner, etc., based on CoSPA
	SA	**General Situational Awareness**
	SA-AFP	**Enhanced Situational Awareness – AFP** Assigned when FCA forecast confidence estimate plots viewed in reference to AFP rate decision, based on CoSPA
	SA-R	**Enhanced Situational Awareness – Route (Enroute Airspace) Impact Monitoring**
	SA-T	**Enhanced Situational Awareness – Terminal Impact Monitoring (TRACON to Terminal Airspace)**
Using TFI	SA-TFI	**General Situational Awareness**
	TFI-AFP	**Improved AFP Execution / Management** Assigned when TFI used to aid in an AFP Go/No-Go decision, AFP decisions on start time, stop time, rate, plan modifications, etc.
	TFI-GDP	**Improved Ground Delay Program Execution / Management** Only assigned when decision aided to explicitly avoid GDP, to implement GDP, to modify rate/scope, or to end GDP, based on TFI
	TFI-Planning	**Improved Traffic Management Initiative Planning**
	TFI-R	**Enhanced Reroute Planning** Includes aiding in reroute decisions by recognizing viability of nominal routes, proactive reroute implementation, and ending reroutes/returning to nominal routes sooner, etc., based on TFI

Figure 11 shows the distribution of benefits for each field observation day for all facilities visited on the particular day, and the totals across all days and facilities. The observations from which these statistics are derived are found in Appendix B. Observers documented 144 instances when CoSPA and/or TFI were used operationally, with 82 attributed to TFI. The most common use was for situational awareness, for which there are five categories (SA, SA-AFP, SA-R, SA-T, and SA-TFI). There were 100 observations of General Situational Awareness (SA and SA-TFI, 37 and 63 respectively) and 21 observations of support for AFP go/no-go decisions (9 for AFP and 12 for TFI-AFP).

Figure 12 shows the distribution of benefits by facility for those facilities that were visited on each of the four field observation days (ATCSCC, ZDC, ZOB, ZNY, and JetBlue). The users for whom the most benefits were recorded are JetBlue and ATCSCC.

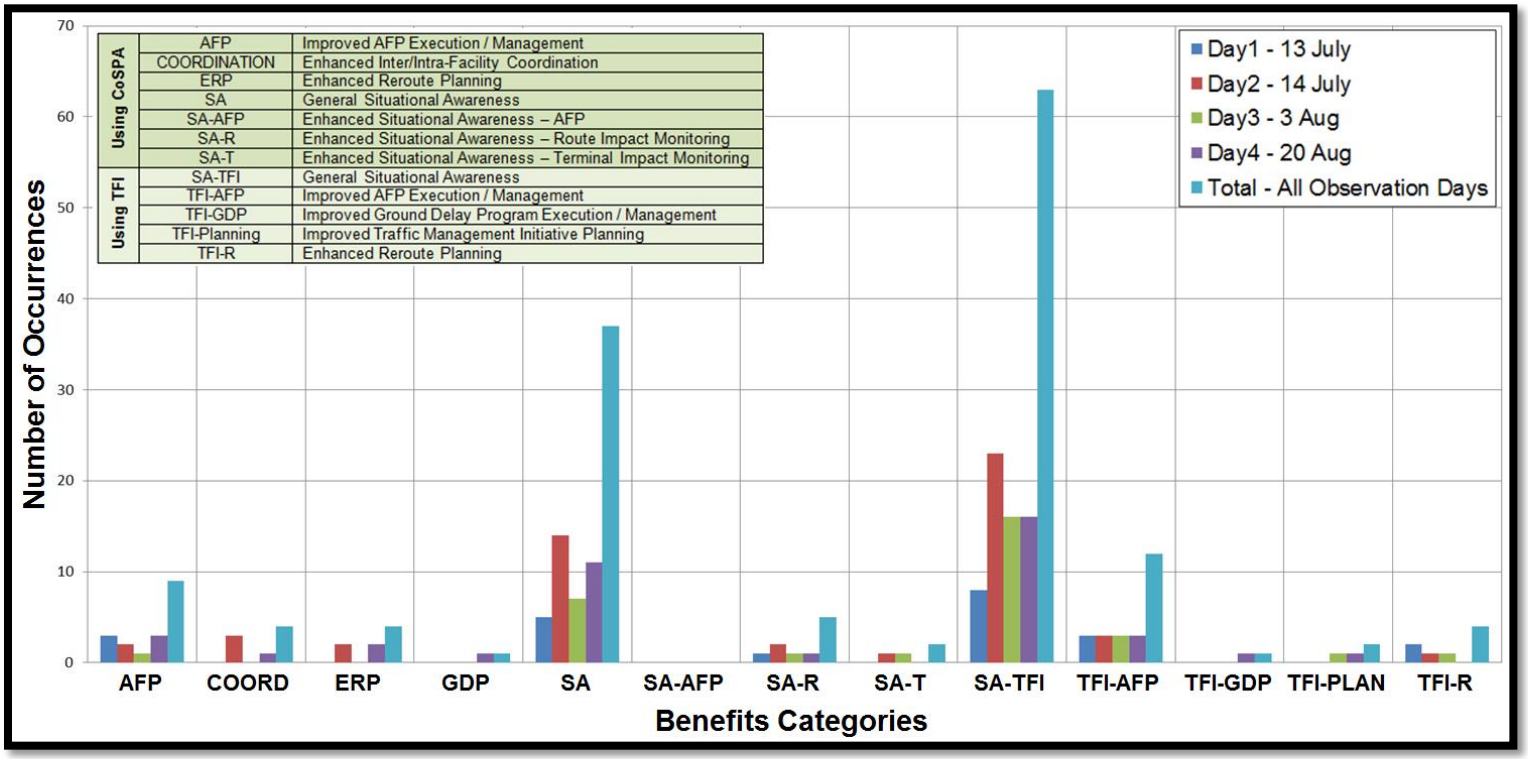

Figure 11. Distribution of benefits by observation day across all facilities.

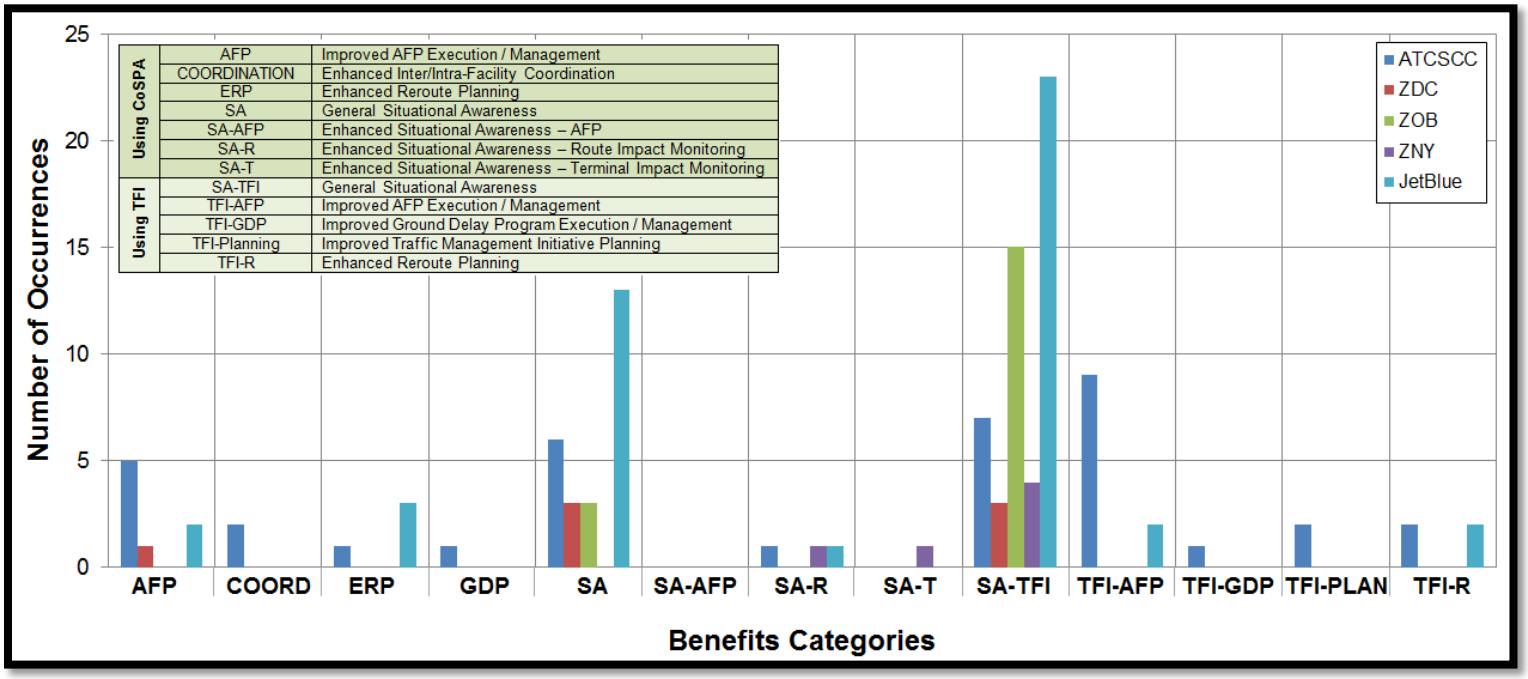

Figure 12. Distribution of benefits by facility.

3.3 EXAMPLES OF OBSERVED OPERATIONAL USE OF COSPA AND TRAFFIC FLOW IMPACT

Observers documented the use of CoSPA and TFI during the four field observation days. Two of those days are analyzed in detail in the following sections in order to highlight how the products were used to provide operational benefits. Discussions for the remaining two field observation days are provided in Appendix C.

3.3.1 Enhanced Reroute Planning (14 July 2015)

July 14th was the second consecutive day in the only multi-day observation visit of the season. Although many airline and FAA users were viewing TFI for only the second time this SWAP season, MIT LL observers recorded fifty benefit entries, twenty-six unique to TFI. A noTable example from this day was recorded at the JetBlue facility and involved using CoSPA and TFI, in tandem. The air traffic coordinator at JetBlue used the CoSPA 8-hour forecast and TFI permeability plot to track five specific flights. These flights were multi-segmented routes that included high priority customers[8] with multiple connections. Therefore, accurate arrival and departure times were critical when managing these flights. They were considered "high impact" to operations and involved proactive flight following and reroute planning (the Enhanced Route Planning or ERP benefit).

High skill was exhibited in the 8-hour CoSPA forecast on this day (Figure 9) throughout the strategic planning period. Consecutive forecast model runs displayed widespread thunderstorm activity throughout the Ohio and Tennessee Valleys associated with the large-scale cold front moving through the region. ATC coordinators also utilized the TFI permeability plots on this day to capitalize on the specific timing needed to plan these flights. Figure 13 provides three consecutive model forecast plots of TFI permeability that coordinators reviewed during the strategic planning period. Each additional run was very similar to previous versions and this steady pattern allowed JetBlue to plan each flight with a high degree of confidence.

[8] High priority passengers are those with connections and/or International passengers. These are high priority because of the cost of rescheduling those with missed connections.

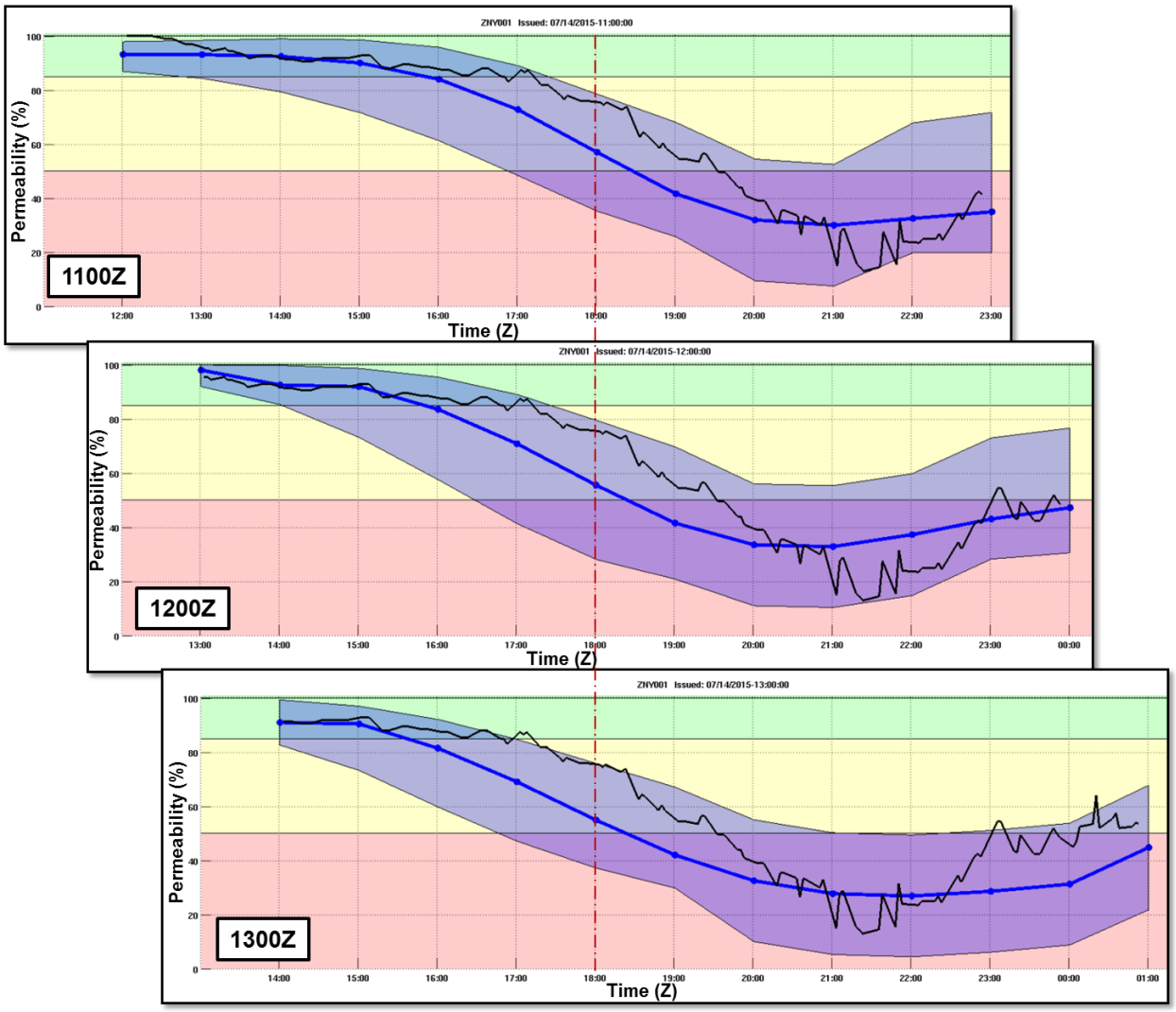

Figure 13. TFI Permeability plots of the ZNY001 region on 14 July 2014 taken at 1100Z, 1200Z, and 1300Z. The plots are time-aligned to show the consistency in timing, intensity, and confidence of the forecast convective events throughout the critical strategic planning period. The blue line represents the permeability forecast, black is the verification, and blue shading represents the confidence interval (10^{th} and 90^{th} percentile).

Figure 14 represents a snapshot of weather and air traffic taken at 2100Z on 14 July 2014 using Flight Explorer [9] which combines 1km NEXRAD radar and actual flight tracks across the NAS. Two of the five JetBlue flights discussed above (JBU514 and JBU480, shown in Figure 14) are part of the main flows of traffic heading to the Northeast.

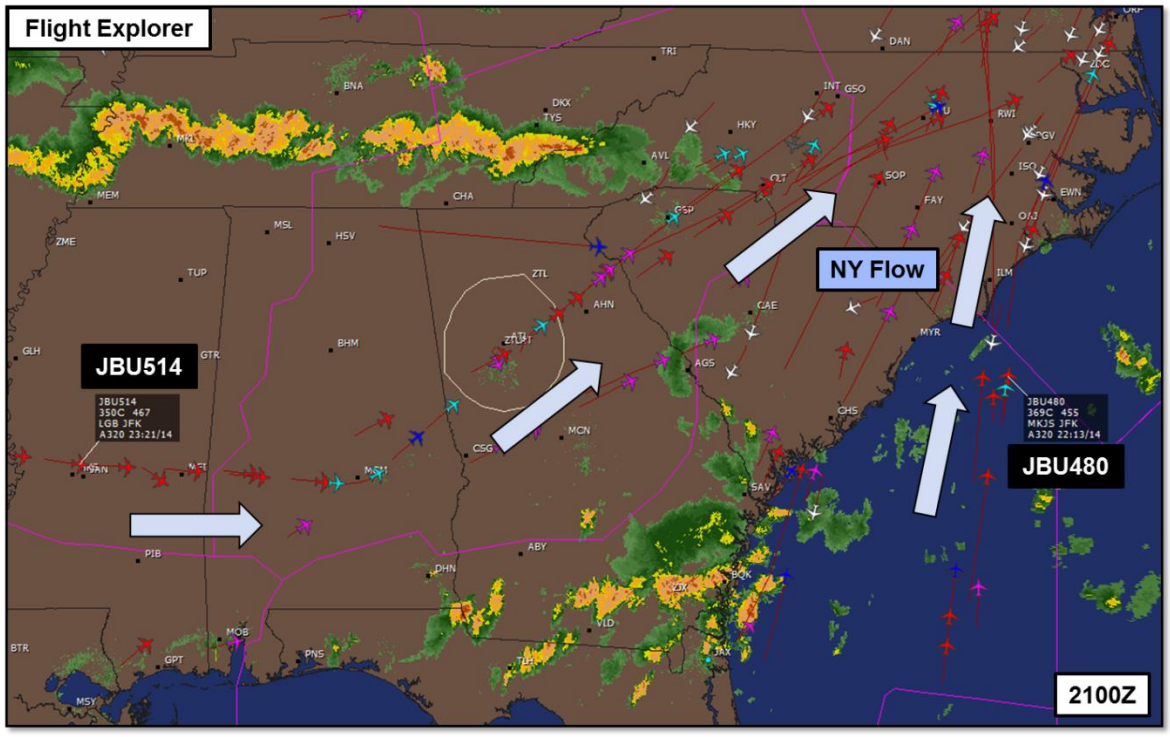

Figure 14. Image taken from Flight Explorer displaying 2100Z NEXRAD 1km radar and instantaneous snapshot of flight tracks on 14 July 2015.

The combination of the large scale structured thunderstorms, along with consistent forecast on placement and timing, allowed JetBlue coordinators to have confidence in guiding each flight through the expected gap across AFP A08 as shown in Figure 15a. Figure 15b is a 1300Z plot of the TFI region forecast for ZDC001. This TFI region most closely matches AFP A08 which was issued on this day. Low impact was consistently forecasted for several consecutive hours across this region as well. This also gave JetBlue managers confidence that those five flights would remain very close to their scheduled times.

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[9] Sabre AirCentre Flight Explorer (FE) is a global aircraft tracking, information technology and communications solutions provider to the aviation community.

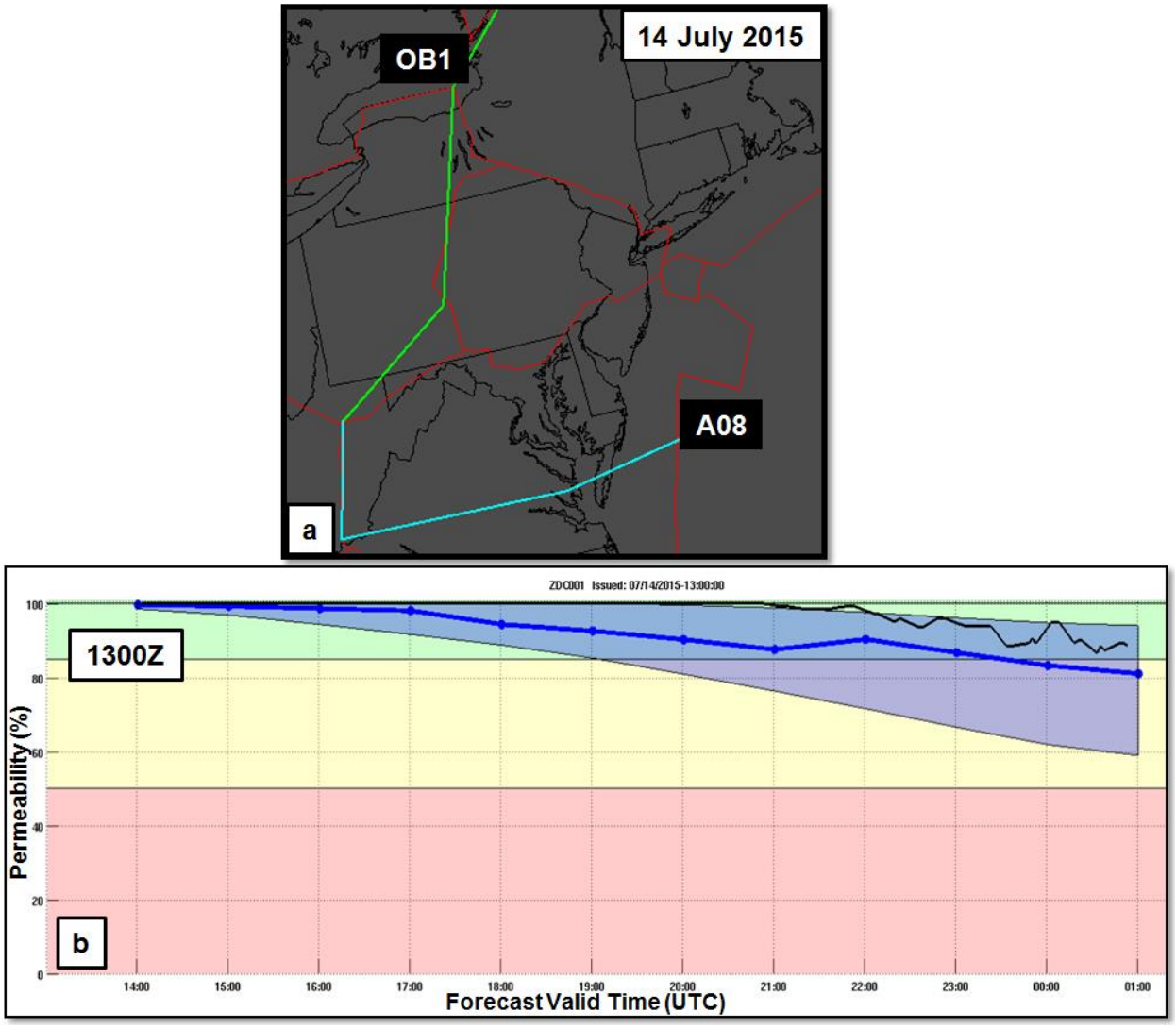

Figure 15. Diagram representing (a) the two AFPs in place on 14 July 2015 (b) permeability forecast for TFI FCA ZDC001, which most closely matches AFP A08. Note the lack of impact expected through much of the day across this region of airspace.

3.3.2 Improved AFP Execution, Management and Situational Awareness (3 August 2015)

August 3rd was the second field observation period of 2015. Evaluation of TFI continued at all FAA and select airline facilities (JetBlue, American and Southwest Airlines). Thirty-one separate CoSPA and TFI benefits observations were noted, despite the lack of thunderstorm activity and generally low-impact

to the NAS experienced this day. In fact, the statistics listed in Table 1 show that the delay recorded on 3 August was the lowest during the 2015 CoSPA observation period.

Observer notes indicated that ATCSCC, ZOB and ZDC, in particular, were engaged in evaluating TFI during the strategic planning period due to the forecasted location of storms. Three AFPs were used to manage traffic on this day, JX7, OB1 and A08 (Figure 16a). There are typically only two AFPs issued during severe weather events, however, on this day, storms were forecast to erupt along a wide swath in the east, from Maine to northern Florida. Air traffic between JX7 and A08 constitutes a major flow between the Northeast terminals (BOS, EWR, LGA, and JFK) and Florida. There are multiple scheduled flight segments between each of these cities per day and the preference is ***not*** to have JX7 and A08 in place at the same time. If this were to occur, flights traveling southbound through JX7 on the first flight segment and then northbound through A08 on the second flight segment would incur additional delay with each transit of an AFP. Figure 16b and Figure 16c show the 1300Z CoSPA VIL truth and 5-hour forecast (valid 1800Z) that ATCSCC planners and specialists were viewing on the morning of August 3rd.

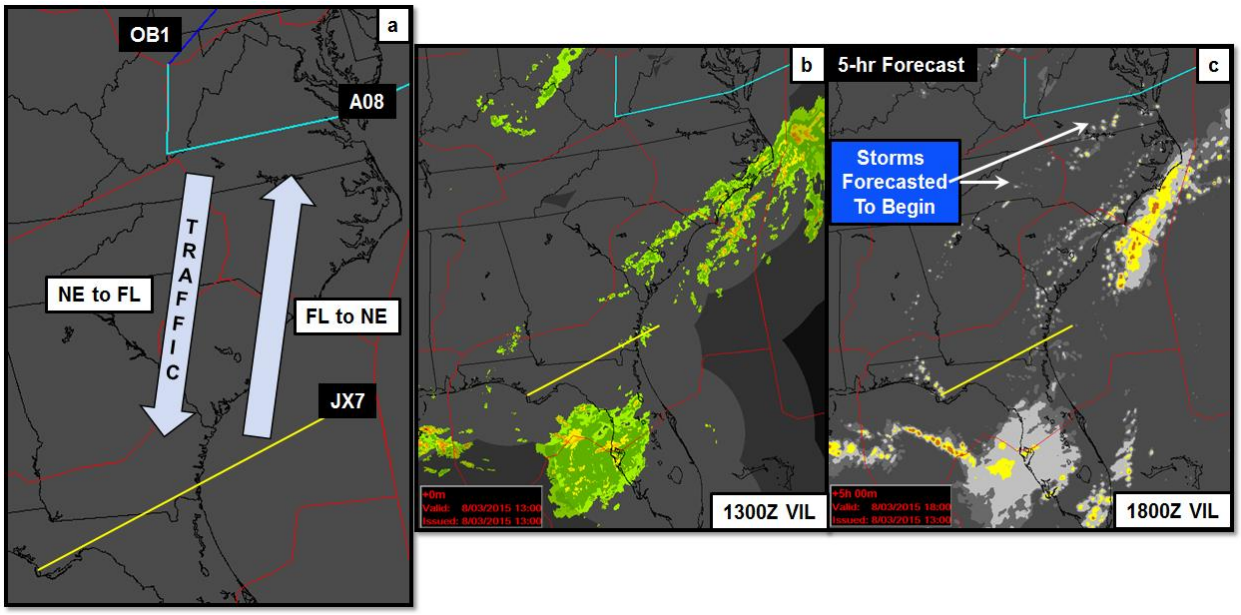

Figure 16. (a) Graphical representation of the three AFPs in place on 3 August 2015, (b) the 1300Z VIL truth, and (c) the 5-hour CoSPA VIL forecast.

The 5-hour CoSPA forecast indicated that storms would remain across central and western FL while new storms began to initiate across southern VA and northern NC by 1800Z. The air traffic planner and enroute specialists at ATCSCC used the CoSPA VIL forecast in tandem with the TFI plots of permeability and forecast confidence (Figure 17) to estimate when to end the AFP JX7 and begin AFP

A08. (Note: TFI FCA ZJX001 and ZDC001 are surrogates for JX7 and Z08, respectively.) TFI suggested that conditions across AFP JX7 would improve by approximately 1800Z. This allowed the cancellation of the JX7 AFP across that region and the start of AFP A08 to the north. The National Operations Manager (NOM), who directly oversees daily activities at the ATCSCC, commented that an application like TFI could potentially allow traffic managers the ability to "approach strategic operations more surgically on a daily basis with greater confidence and efficiency." The basis of this statement lies in the ability to use TFI in order to gauge three important factors in strategic TMI planning of a convective event:

1. **Onset:** When will the event begin and when should the TMI be issued?
2. **Duration**: How long will the event last and when can recovery begin?
3. **Severity**: How intense and widespread will the storms be and how much does demand need to be reduced?

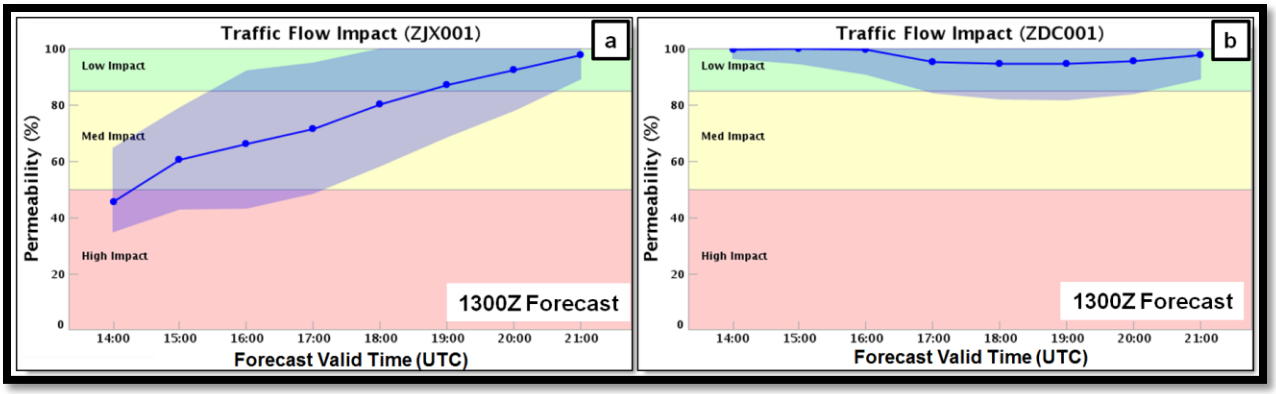

Figure 17. 1300Z TFI plots of permeability and forecast confidence for (a) ZJX001 and (b) ZDC001 on 3 August 2015. TFI FCA ZJX001 and ZDC001 mimic AFPs JX7 and Z08, respectively.

Figure 18a provides a plot of the TFI permeability forecast (computed in real-time from forecasts; blue line) and verification (computed post-event from archived weather data; black line) for the third AFP (OB1) issued on 3 August; the low-impact forecast verified. A secondary strategic discussion on this observation day involved the severity of the event expected. Figure 18b provides permeability estimates for TFI FCA ZNY001 (which mimics the ZOB/ZNY boundary portion of AFP OB1) computed from several different forecasts, including SREF (**black**), LAMP (**green**), and three separately time-lagged forecasts of the HRRR (**red**).

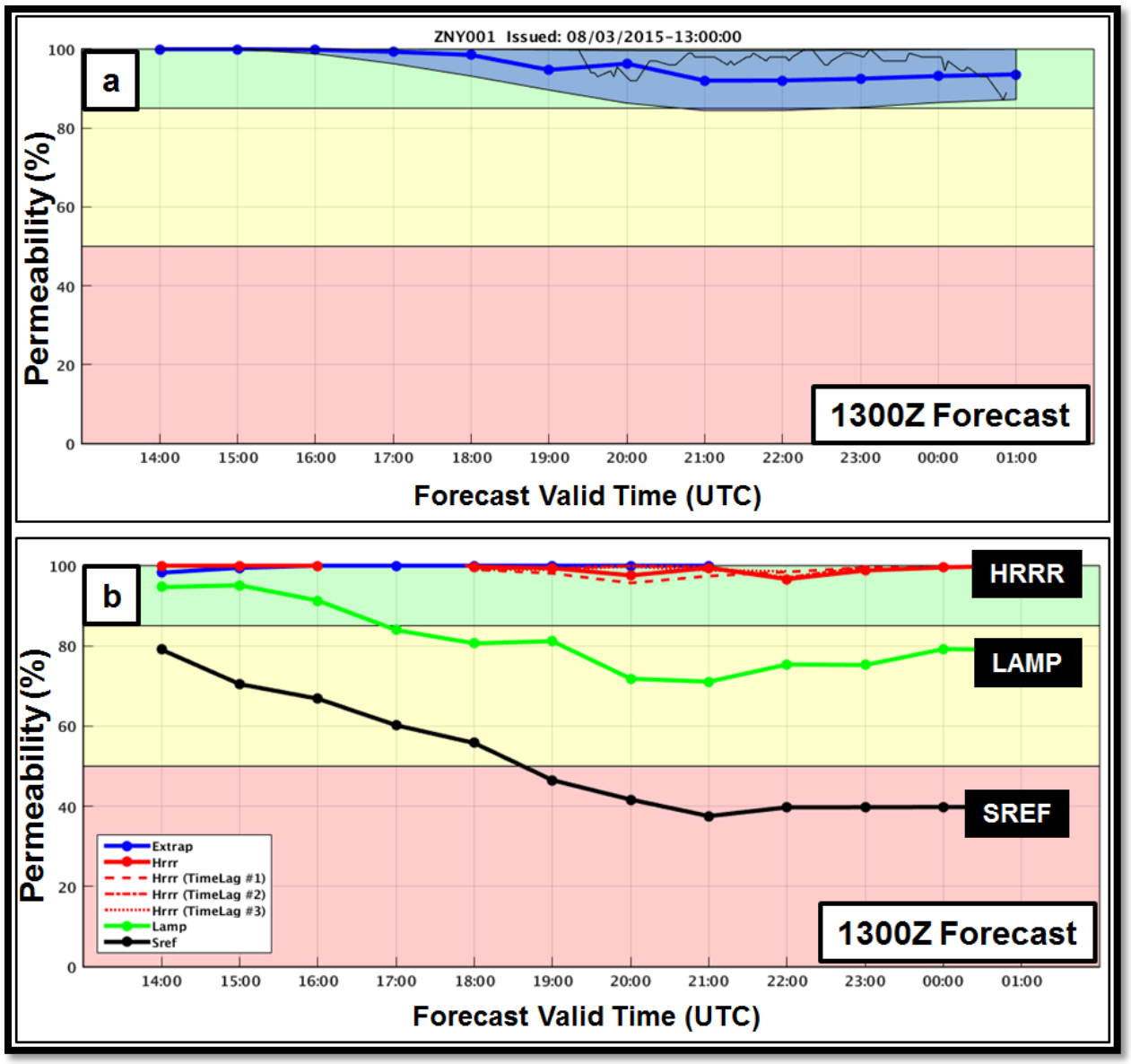

*Figure 18. 1300Z plots of (a) TFI permeability (blue line), permeability verification (black line) and forecast confidence (blue shaded) and (b) the permeability computed from individual forecasts from SREF (**black**), LAMP (**green**) and HRRR (**red**) on 3 August 2015 for TFI FCA ZNY001, which mimics the ZOB/ZNY boundary portion of OB1.*

Morning forecast guidance, specifically from the SREF, indicated that a strong line of storms would develop and affect much of the Northeast and Ohio Valley by afternoon, and this is the forecast the NOM

provided to ATCSCC planners. CoSPA and TFI predicted much less activity with only scattered, light to moderate storms across the region. Storms remained scattered across the Ohio Valley and Northeast with one small line of storms developing to the north of the NY TRACON N90 (Figure 19). There were fewer arrival/departure cancellations on August 3rd than any of the other days in Table 1, with only four diversions and no recorded airborne holding in the Northeast region.

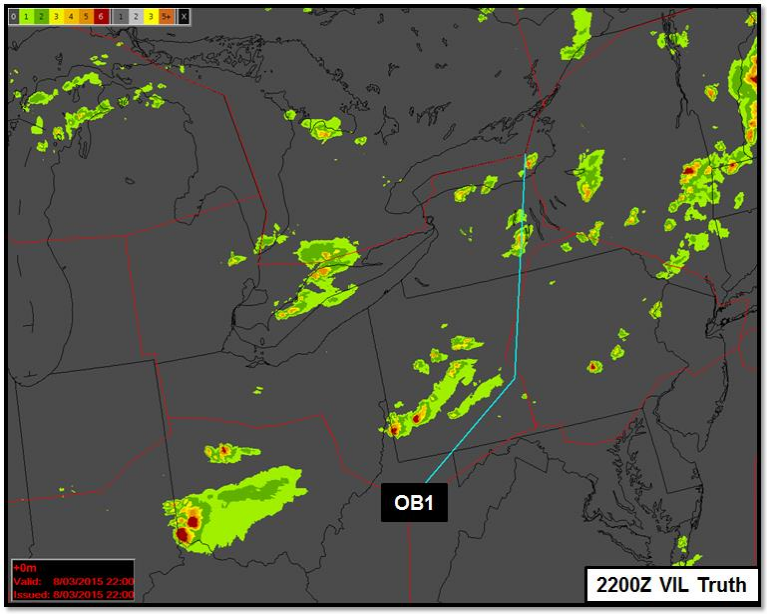

Figure 19. 2200Z CoSPA VIL truth centered over the Ohio Valley on 3 August 2015; OB1 is plotted in cyan.

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4. USER COMMENTS AND REQUESTS

4.1 FIELD OBSERVATIONS

During field evaluations, observers noted, among other observations, any requests for changes or additions to the CoSPA and TFI product suite. This section details those requests.

User requests are presented in Appendix D. The most common user request (34 of 63) pertained to the TFI FCAs. Thirteen users wanted more TFI FCAs to cover more airspace, nine wanted TFI FCAs to match traditional FAA AFPs, and four wanted TFI FCAs to be linked in some manner to sectors. Three users wanted to be able to create TFI FCAs dynamically, which is a capability available on the Traffic Situation Display (TSD).

Another common user request (five) was for quick access to the Permeability plot. In the current TFI configuration, users must expand the timeline list for the ARTCC containing the TFI FCA of interest, and click the associated link to display the Permeability plot (Figure 20). Five users requested quicker access to the plot by, for example, clicking, or resting the cursor on, the TFI FCA overlay (cyan in Figure 20), causing the plot to be displayed.

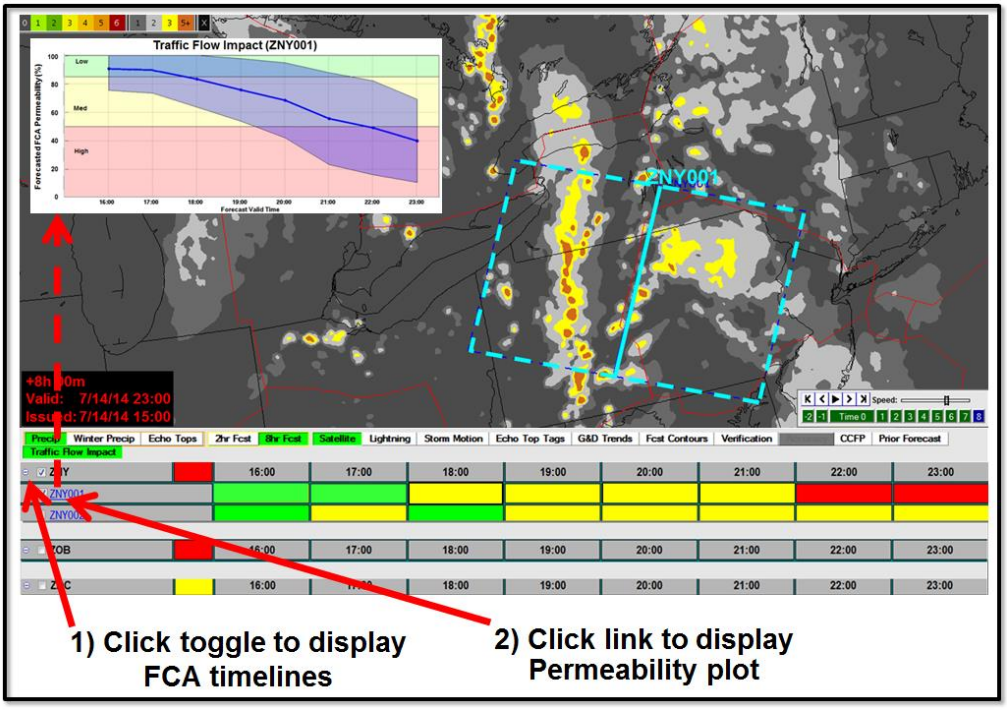

Figure 20. Steps required to display the Permeability Plot during the 2015 observation period.

TFI provides an estimate of permeability for a particular TFI FCA. Permeability is a measure of how much of the impacted airspace is usable by air traffic. Air traffic managers use permeability to determine appropriate flow rates for the program. Five users requested that the permeability plot also include an explicit estimate of flow rate.

While formally documented only six times during the 2015 field observation period, a user request heard often by observers was the desire for CoSPA and other products (TFI and RAPT) to be available on the Situation Displays (SDs) currently hosting CIWS. Web-based products are difficult for air traffic managers to use consistently because web access is limited in the facilities; often available only to STMCs and only on the computer that hosts other frequently used applications. For this reason, it is often not possible for the user to open a CoSPA/TFI window and leave it open for the entire shift. In addition, in many FAA facilities, the TMCs are actively involved in planning the timing and rates for AFPs, GDPs, and reroutes. These users typically do not have web access at their positions so the products are not available to them during planning. However, nearly all TMCs in the facilities use the stand-alone CIWS displays. Those users who recognize the benefits these products can provide routinely ask that the products be displayed on the SD so they can be easily accessed and readily available.

Other user requests included:

- Merging TFI and CoSPA with other products such as Dynamic Weather Routes (DWR), traffic for metering, Meteorological Terminal Aviation Routine Weather Report (METAR) routes, Airport Surface Detection Equipment (ASDE)-X, and Aerobahn
- AdjusTable timelines (completed during Summer 2015) and email capability
- Forecasts to 12 hours and beyond
- User-specified color palettes
- A way to know which FCAs ATCSCC is viewing
- Forecast Confidence expressed as a percent (similar to CIWS Forecast Accuracy)
- Standardized window configurations
- TFI trend information
- Reorganization of FCAs in the timelines to associate them with different ARTCCs

4.2 SURVEYS

After the field observation period was completed, seventeen users from ATCSCC, ZDC, ZOB, and JetBlue were asked to provide detailed feedback on TFI by answering specific survey questions. These

users were chosen because they were the most active users (based on number of benefits) of all facilities visited. The full results of the survey are presented in Appendix E. Users were asked to provide feedback on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree) on a variety of questions regarding the ease of use and accuracy of the TFI product.

The distribution of responses to all questions is provided in Figure 21. Users generally approved of TFI and the timeline display concept. Reviews of the accuracy of the products, and permeability/forecast plots in particular, were mixed but generally good. Given that this was the first season that TFI has been available operationally, these results are not surprising. It is expected that some tuning and site adaptation of the algorithm would be needed to improve performance, and users would need time to become familiar with and learn to use the product effectively.

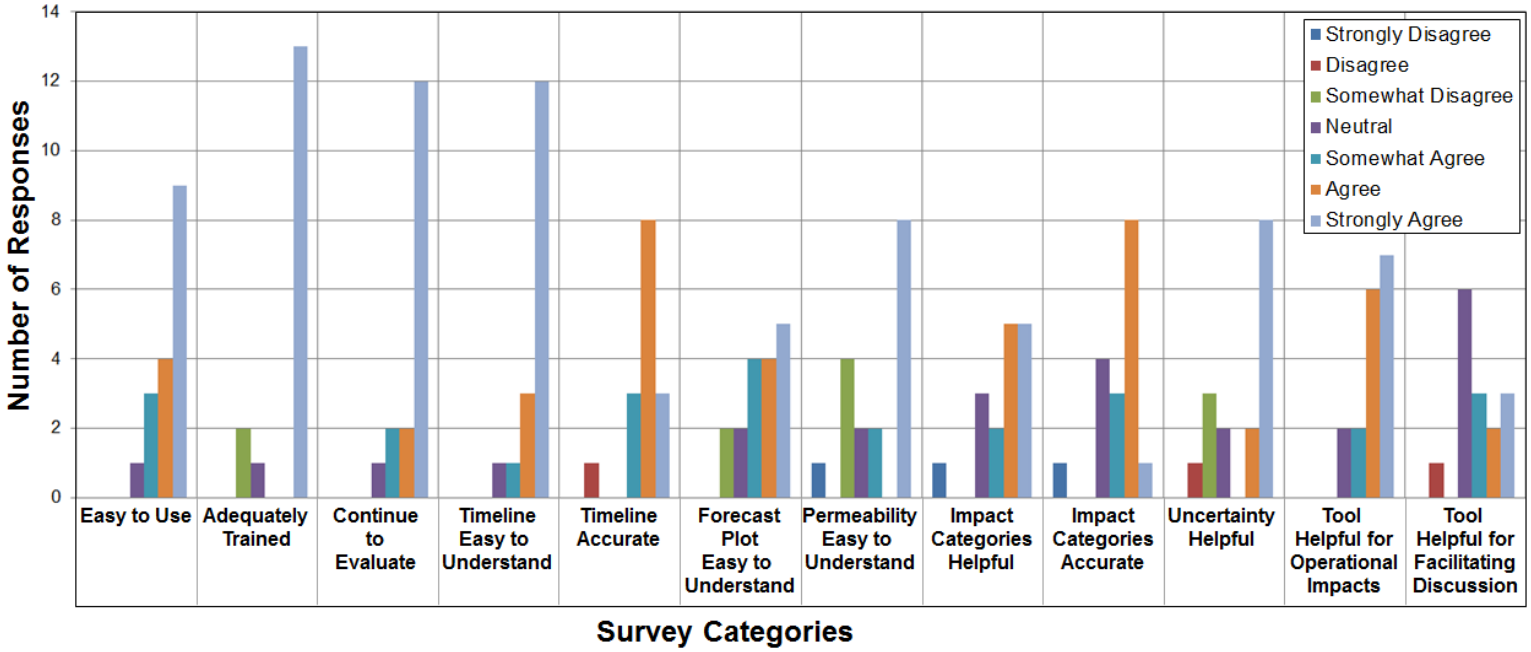

Figure 21. Distribution of user responses to survey questions.

User comments were documented during the survey process and are also provided in Appendix E. Many of these users were the same users who provided comments during field observations, so some duplication of responses is expected. These users repeated their opinions that: there should be more TFI FCAs, TFI FCAs should match standard AFPs, user should be able to draw TFI FCAs dynamically, users want CoSPA and TFI available on the SD, and permeability should be converted to rate. One user commented that the smaller FCA regions, which effectively break standard AFPs like OB1 into sections, could be used to evaluate arrival and departure corridors. Multiple users expressed a desire to have the products available year round, rather than just during the demonstration period.

Finally, one Center Weather Service Unit (CWSU) suggested that more in-house verification, as a team effort between CWSU meteorologists and TMU, needs to be done to assess the accuracy of the product for operational usage.

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5. SUMMARY

This report presents the results of observations recorded during the operational use of CoSPA and the decision support application, TFI. This newly developed application is used to predict the impact of convective weather on operations using a flow-based permeability measure. The 2015 CoSPA field observation conducted between 13 April and 31 October allowed MIT LL observers to travel to five separate FAA facilities and five different airline operation centers. These visits covered four convective weather days, documenting over 300 hours of observations. One hundred forty-four separate overall traffic management benefits were noted, 82 specific to TFI.

TFI was developed to address a current shortfall in strategic planning by providing explicit translation of convective weather forecasts into resource constraints for traffic managers. Air traffic managers, in both the FAA and airline community, work in an environment fraught with complexity and uncertainty, often not having the appropriate tools to guide them in their traffic management decisions during convective weather. Evaluation results of TFI were encouragingly positive, considering exposure was limited during the 2015 SWAP season. ATCSCC planners stated, "This tool has been the first of its kind that we've seen in here (ATCSCC). I'll need to work with it (TFI) more, but I feel it's a step in the right direction…a big step!" The traffic managers immediately understood the concept of TFI and were able to envision how this application would be incorporated into their decision-making during severe weather events. The largest number of recorded benefits fell into the TFI General Situational Awareness and Improved AFP Execution Management benefits categories. Improved AFP execution and management was also found to be beneficial to both the FAA and airlines, specifically aiding in go/no-go decisions as well as determining the onset, duration and intensity of the convective event. Users declared that "the tool was useful to generate discussion when it came time to decide if AFPs or re-routes might be needed."

Users displayed an immediate aptitude for using the TFI product which allowed them to quickly envision ways to adapt the application to their everyday use and to generate new ideas on capabilities to be developed. Most common was the need to have TFI regions that mapped directly to current standardized FAA AFPs and to provide actual rate suggestions. This change would provide a common baseline for comparison with current standard AFP rate settings and those suggested by TFI. Users further communicated a desire to expand the number of TFI regions to other parts of the NAS where capacity is greatly affected by convection, e.g., Chicago, Dallas, and Atlanta Centers.

An additional user request that has been documented in past observations is the desire for CoSPA and other decision support products, such as TFI, to be available on the SDs currently hosting CIWS in FAA and airline facilities. Web-based products are difficult for air traffic managers to use consistently because web access is limited in the facilities. The users stated that products like CoSPA and TFI would be more useful if they were readily accessible on the current stand-alone CIWS SDs or on any platform that provided stand-alone access to the products.

For successful planning of TMIs, decision makers require weather forecasts of the impacted airspace between two and eight hours in advance of the event to set the critical parameters of the TMI such as start time, duration, and maximum flow reduction. Several weather-only convective forecasts such as CoSPA, SREF, and CCFP, are available to the traffic planner in the strategic time domain. However, these forecasts provide little guidance about aviation impact on the air traffic resources and the precise location, severity, scale, and timing of operationally significant storms.

Successful strategic planning also relies on the experience of traffic managers and all those involved in TMI planning. MIT LL observers documented a decrease in experienced traffic managers across key east coast facilities and noted that more than sixty-percent of current traffic mangers have five or less years at their current position. Rapid and successive retirements have made it difficult to transfer the accumulated convective weather traffic management knowledge to the incoming managers. Breakdowns in the inter/intra-facility communication and coordination protocol, as well as awareness of key issues in convective weather management for adjacent ATC facilities, have also been noted at multiple FAA facilities. This breakdown in communication can often slow the planning process. By translating convective weather forecast information into the parameters used in selecting TMIs (e.g., time of onset, level of impact [permeability and flow rates], and duration), more effective and timely TMIs can be formulated and assessed in operations. Additionally, communicating forecast uncertainty using those same decision variables provides an objective, quantitative basis to better understand and communicate the risks and benefits of various levels of TMI strategies. However, more research, observations and a defined concept of operations are needed to verify these hypotheses and ensure that decision support information meets user needs. In the future, given objective forecasts from a deterministic weather forecast product such as CoSPA and a translational model like TFI, it would be possible to refine decision support guidance to enable traffic managers to more effectively plan TMIs while reducing the risk related to uncertainty inherent in severe weather planning.

APPENDIX A.
COSPA USAGE AND UPTIME

COSPA WEBSITE USAGE

A new technique for determining usage was implemented on 25 June 2015, so statistics prior to that date are not directly comparable. MIT LL logged the number of "requests" for CoSPA product updates by time and by product. A "request" is defined as a data refresh operation triggered either by user action (e.g., changes to the selection of weather products) or by a real-time update to weather products when new data are available.

It is common for users to set up the CoSPA display to show the products and airspace of interest to their particular application, and then leave the display untouched for long periods of time. They glance at the CoSPA image to quickly get the information needed and move on to other tasks. This practice is so common that users requested the capability to save configurations so they could easily and quickly access layouts specific to their particular needs. Therefore, relying solely on user interaction with the display to measure usage is inaccurate.

Because CoSPA is web-based, it is often available only to STMCs and only on the computer that hosts other frequently used applications. For this reason, it is difficult for users to open a CoSPA window and leave it open for the entire shift. When a CoSPA window is displayed and left open, it is using valuable resources, so it is likely that CoSPA is providing information that the user considers worth the cost of the resources. Therefore counting real-time updates to weather products, even in the absence of user interaction, is a valid measure of usage. CoSPA updates every five minutes, resulting in 12 requests per hour.

Figure A-1 shows the number of requests for each month during the field demonstration. A slight decline in usage is noted in September and October, which reflects a decrease in weather activity. Figure A-2 shows the number of requests by week from 09Z on 25 June 2015 through 08Z 29 October 2015. Figure A-3 provides the number of requests by product. The base products are shown separately (left); VIL requests are 10 times more frequent than other products. Of the remaining products, Satellite and Echo Tops Tags are the most commonly used.

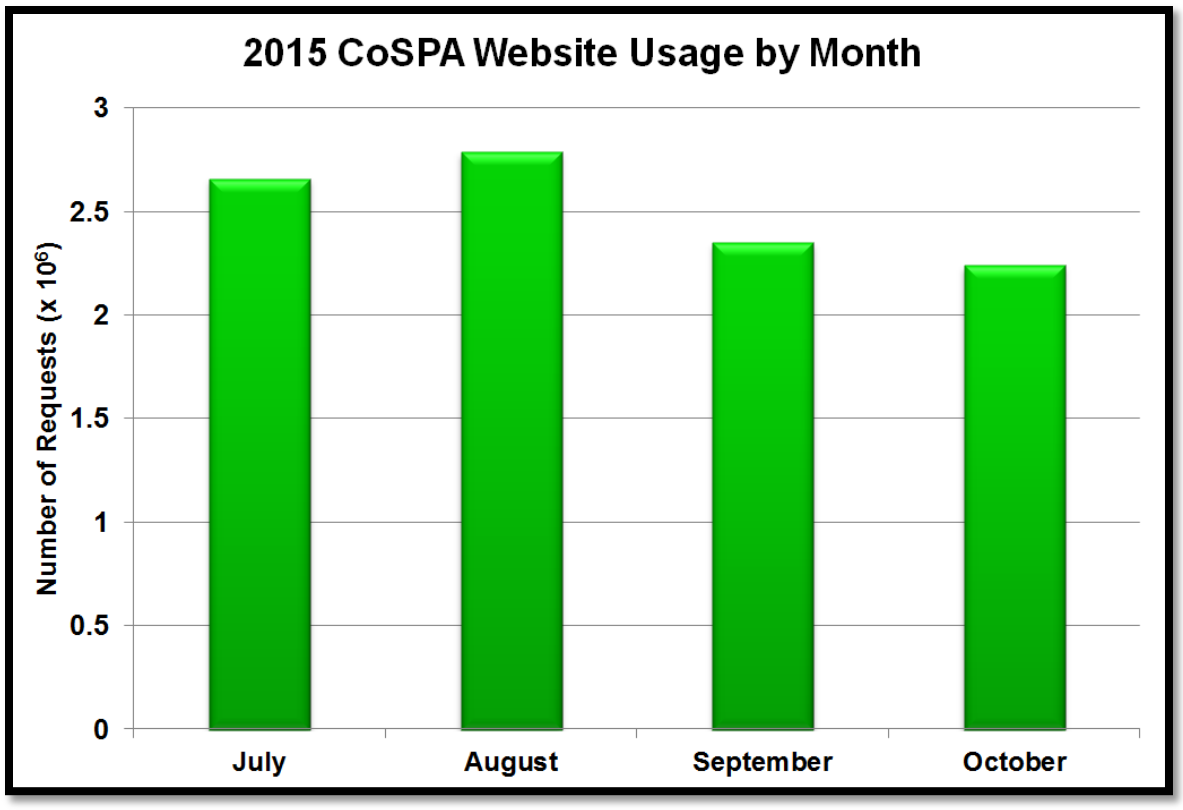

Figure A-1. Number of requests for CoSPA products for each month during the 2015 field observation period.

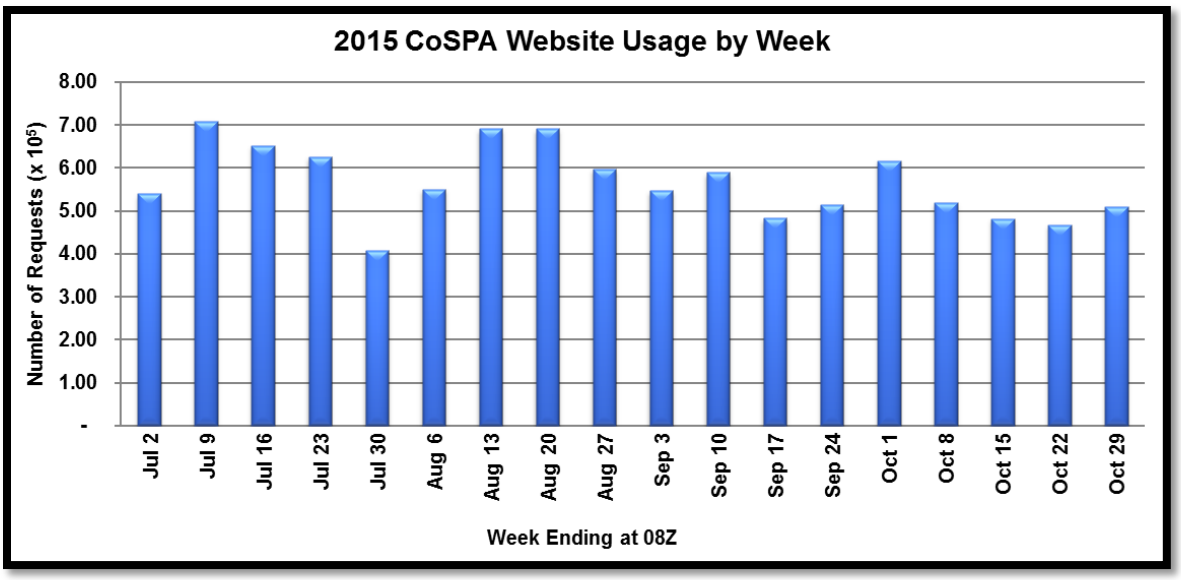

Figure A-2. Number of requests for CoSPA products for week beginning 09Z on 25 June 2015. Weeks begin at 09Z seven days prior and end at 08Z on the day indicated on the horizontal axis.

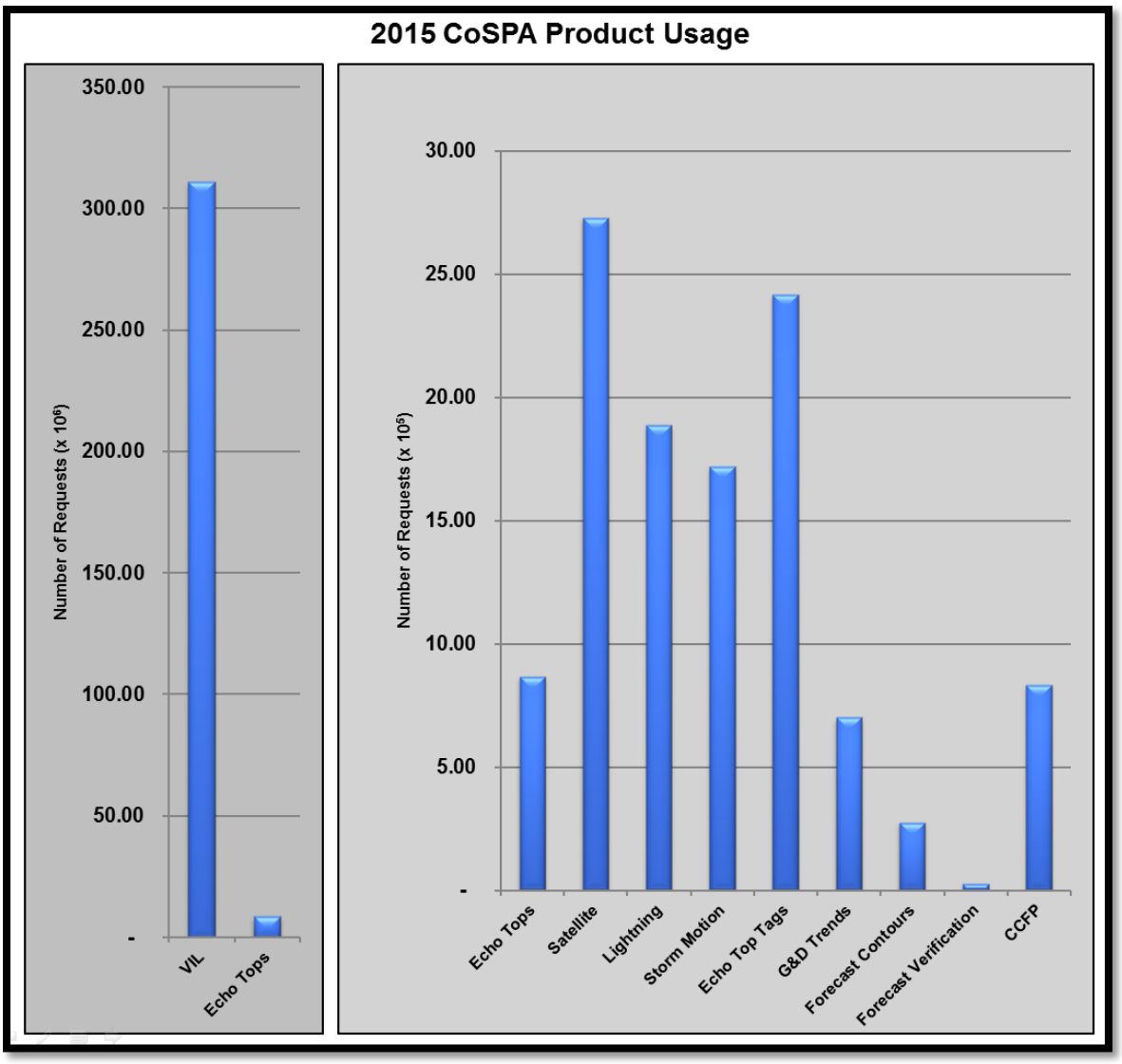

Figure A-3. Number of requests for CoSPA products by product. Base products are on the left with a scale of 10^6. Other products are on the right with a scale of 10^5.

COSPA SYSTEM UPTIME

CoSPA is a non-operational prototype system and is therefore subject to brief intermittent outages. A system of communication and trouble-shooting is established among the laboratories to ensure that the outages are as brief as possible. The uptime statistics for the individual laboratories (MITLL, NCAR, and GSD) and for the combined CoSPA system are shown in Table A-1. With the exception of MIT LL, the individual laboratories achieved uptimes of greater than 99%. However, the overall system uptime for CoSPA during the demonstration was approximately 95%, which was primarily due to a major failure of critical hardware at MIT LL resulting in a total loss of CIWS and CoSPA products for a period of five days (22 - 27 April 2015).

TABLE A-1

System Uptime for CoSPA During the Demonstration Period.

Outage Statistics for 13 April – 31 October, 2015					
	GSD	**MIT LL**	**NCAR**	**Other**	**Combined**
Outage time	2910	10270	175	200	13555
Maintenance	0	290	0	0	290
Uptime (%) including maintenance	99.00	96.37	99.94	99.93	95.24

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APPENDIX B.
FIELD OBSERVATIONS DURING WHICH BENEFITS WERE DOCUMENTED

TABLE B-1

13 July 2015 Field Observations

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1100	Stake-holder	No	Stakeholder meteorologist briefed stakeholders using CoSPA. Some thunderstorms expected in the Northeast.	SA	
1115	Stake-holder	No	SPT: J75 will close soon. No routes available between DC and ORD. ZOB to ORD routes have expired. ZDC is closed to ORD traffic and J48/75 are closed. ZAU is getting planes out dynamically. A DTW Playbook west is needed; NO_WEEDA. ORD: GS possible with 30-50-80 rates. Departures are stopped to the north and east. There will be issues getting to the east coast later on. SWAP west to go south. Pathfinders will be requested. ZMP: BOS to ORD traffic is deviating far to the north. Need MIT and tactical deviations. ZDC: Thunderstorms will decay in the morning and redevelop in the afternoon over the water. ZOB: Convection this afternoon. ATCSCC sees possible AFPs. A05 and A08 are in the Plan and CAN routes are pending. Start time is 1700Z. These two AFPs are usually issued together. BOS: 61 rate and is OK. JFK is on 22L/31L, EWR is on 22. It will be OK today in the NY terminals but the problem will be enroute arrival weather. ZTL: The weather will decay before hitting CLT. GDPs are not planned.		

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1115	SCC	No	SPT: J48/75 closed per ZDC; cannot get to ORD routes. ZAU is handling fast moving squall line. There are significant deviations on the BOS to ORD route. The Planner states that the NAM feels additional storms will develop in eastern OH/western PA and the planner has proposed A05/A08 with 17Z start time. The Planner is using CIWS looping, with SVRWX using CoSPA to begin modeling AFPs. No plan for GDPs in NY/PA at this time.	AFP	
1130	ZOB	Yes	Observer offered to demonstrate TFI to STMC. STMC was very busy so training was worked in between interruptions. Observer noted that since ATCSCC was considering AFPs, it might be worth looking at TFI. Performed training. Noted ZOB002 (the ZAU/ZOB part of A05) was R5Y3 (1145Z). Permeability goes from 10% to 60% from 1245Z to 1945Z, reaching 50%@1745Z.		SA-TFI
1212	Stake-holder	No	Dispatcher is using CoSPA.	SA	
1217	Stake-holder	No	A second round of storms is possible for ORD this afternoon. Air Traffic System Controller (ATSC) uses TFI with a ZOB timeline. Observer noted possible impact to AZEZU.		SA-TFI
1225	SCC	Yes	The SVRWX TMC uses TFI for AFP and CAN route planning, discussing potential rates and whether the forecast suggests AFPs are required.		TFI-AFP, TFI-R
1235	Stake-holder	No	The ATSC says that based on TFI, AFPs are needed to slow traffic; the terminals are OK, but there are problems headed south and west.		TFI-AFP
1245	Stake-holder	No	Webinar: ATSC consults TFI for ZDC before the webinar started. TFI shows RED at 17Z. BIGGY and LANNA are already stopped. The 17Z CCFP is not correct and models are not handling convection well, especially in the Midwest. The squall line will move southeast and redevelop across the Southeast. It will be a complex weather day, but no terminal impacts. AFPs are likely. The energy fueling the squall line will move into the Ohio Valley and coverage will increase. A06 and A08 for ZDC, OB1 and A05 for ZOB are possible. AZEZU will be available for a route-out. Centers can use CDRs. ATCSCC is talking about conservative rates through A05 (60 - 80). Rates for A08 are 70 - 90. Delays of 50 - 60 min are modeled. Stakeholders say the rates are too low.		SA-TFI

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1249	Stake-holder	No	The stakeholder is looking at the AFP in FSM and at the CoSPA/CCFP forecast loop. A05 and A08 rates are discussed.	AFP	
1255	Stake-holder	No	ATCSC says that TFI agrees with the low rates suggested for the AFPs. Another stakeholder feels the rates are too low and wants AFPs along the ZOB/ZAU, ZOB/ZID boundary, or ZDC AFP; wants A05 split because it does not help for weather in Pennsylvania.		SA-TFI
1300	Stake-holder	No	CIWS SD is used to determine where weather is and will be on J6 and J42. There is also extensive use of TFI to determine ORD routing.		TFI-R
1504	Stake-holder	No	TFI was used to prepare for the 1115Z SPT.		SA-TFI
1615	SCC	Yes	THE SVRWX TMC discusses the TFI for ZDC. Models do not indicate storm development yet ZDC meteorologists believe this region will be a problem. If storms develop in ZDC, SVRWX will take traffic around the backside (through ZOB) but ZOB is already overloaded. If weather does not develop in ZDC, SVRWX would rather take TX/MGM traffic through ZDC.		SA-TFI
1655	SCC	No	SVRWX uses CoSPA/TFI to evaluate whether AFPs are needed. The observer conducted TFI training.		TFI-AFP
1704	ZDC	Yes	The STMC asks to see CoSPA after it was referenced on the sidebar. He has changed his mind about AFPs. "I used the information we had (CCFP)."	AFP	
1715	ZOB	No	SPT: The STMC noticed improvement forecasted by TFI. If FL and TX traffic comes through ZOB, then ZDC will not need an AFP because the demand is reduced. CWSU at ATCSCC says the atmosphere is unsTable in NW ZDC/S ZOB/S ZNY; expects development VA to NC and OH/PA border to central PA. Development is more significant after 18Z. CCFP is not performing well today. Forecasting 50% coverage at 18Z. Delta says CIWS/CoSPA show dissipation but CWSU says they use the same model inputs are therefore are also not forecasting well. Conclusion is A01 and ZDC4 at 18Z; no LGA/JFK GDP. One West and two East (1 for ZBW and 1 for ZNY) CAN routes.		SA-TFI
1745	Stake-holder	No	The observer conducted TFI training. During the training, the ATC supervisor consulted TFI and CoSPA and believes AFPs will be canceled by 00Z; does not believe AFPs were needed to begin with.	SA	SA-TFI

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1853	Stake-holder	No	ATSC noticed that CoSPA CAN route overlays are not current. An ICR is issued and FCA010 was proposed. ATSC is using CoSPA to check weather for the DC area. The observer conducted TFI training.	SA	
1911	Stake-holder	No	SPT: AFPs are in effect. There is holding for MDW. An ICR was added to the route structure. The ATSC uses CoSPA to check on L455 and M201 through 21Z. ZDC reports there are no inland routes. Southbound traffic is deviating into northbound flow. ICR is for ZNY and ZBW departures only. AR8 is closed but all others are open. ZAU says new cells will develop in the next couple of hours. ZKC is moving traffic around the weather and they expect problems later. ZBW reports that traffic on CAN West is deviating near PGB, a ground stop for BOS is possible (haze) after 20Z. One stakeholder wants to implement ICR in southern ZDC and northern ZJX and eliminate AFPs. ZDC said the AFP might overwhelm them. ZOB says the AFP is working ok. EWR GDP is ok. MDW GS is canceled. ZAU expect storms in north and northwest to redevelop and impact the terminals. An ORD GS after 22Z is possible. The ATCS monitored CoSPA throughout the SPT.	SA-R	
1915	Stake-holder	No	SPT: ZDC said they are running ICRs for southbound traffic only. Planner said the diversion recovery page is open. There are 2 east CAN routes and 1 west CAN route. The new ICR for southbound ZDC traffic for ZJX and ZMA arrivals only. All AR routes are open. ZJX mentioned 6pm as the problem time for MCO terminal being impacted with thunderstorms. ZAU much better and not much weather now but another wave is expected coming from north and west. ZDV has popcorn thunderstorms forming around their airspace so tactical reroutes will happen. A stakeholder mentioned that he wants to use ICR to eliminate AFPs. Planner said he will discuss it with ZDC and Severe Weather offline and will look at it. Stakeholder used TFI and echo tops forecast.		SA-TFI
2037	Stake-holder	No	NY SWAP was issued at 1730Z; DC SWAP was issued at 1556Z.		
2045	ZOB	No	Quiet in unit. Some tactical talks with ZDC.		

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
2117	Stake-holder	No	SPT: CoSPA is up during the entire SPT. A derecho is moving through. One stakeholder wants to end the AFP to the north. There is about two hours of demand before the AFPs drop off. ZJX reports TS over MCO. There is new development west and northwest of ORD and they may lose the west and south departures. ZNY wants to dial back after 2300Z. MSP ground stop is possible. ZNY says only J6, WHITE/WAVEY, and OOD are available. The EWR GDP is running well. ZID is losing the N/S ability and need SWAP and reroutes to DTW.	SA	

TABLE B-2

14 July 2015 Field Observations

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1100	Stake-holder	No	The ATSC checks TFI prior to the SPT. ZOB and ZBW timelines are very red. A bow echo is in Kentucky and entering TN and NC. AR routes are already closed because of thunderstorms and military operations.		SA-TFI
1110	Stake-holder	No	The TFI website is not displayed at any position at this time; CIWS and CoSPA are being used. This stakeholder has two stand-alone displays that are used to display CIWS.	SA	
1110	SCC	No	The SVRWX TMC uses CoSPA and TFI to evaluate storms that are expected to develop. A request was made for a TFI forecast out to and beyond 12 hours and for a percent score for the confidence/accuracy of the forecast, similar to CIWS.	SA	SA-TFI
1115	Stake-holder	No	SPT: An active weather day is expected with many routes and possible AFPs, GDPs, and CAN routes. L453/M201 and AR routes are closed. ZDC is passing back MIT. ZTL says weather is approaching CLT from the northwest. No significant weather at BOS. PCT is expecting ground stops. ATSC says the 60-rate AFP yesterday was too low and an 80 rate would have been better. One stakeholder said (on the airline recap for yesterday) that TFI should have been used.		*TFI-AFP

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1121	Stake-holder	No	The stakeholder used TFI to assess impact on FCA ZOB1 for CAN route entry/exit.		SA-TFI
1141	ZDC	Yes	The STMC says weather in southern NJ is really bad for ZDC airspace. It blocks ZNY and ZBW. The STMC consults CoSPA for situational awareness.	SA	
1150	Stake-holder	Yes	The observer conducted TFI training. One user stated "This will be interesting to watch today." The user assessed ZNY001 for situational awareness.		SA-TFI
1157	Stake-holder	No	The ATSC briefs the Manager of Air Traffic System Control using TFI and notes the fixes and rates for N90.		SA-TFI
1200	ZDC	No	The STMC asked about TFI rates and the observer demonstrated the product.		SA-TFI
1200	ZOB	No	TFI is displayed; waiting for the weather to develop.		SA-TFI
1215	Stake-holder	No	The observer displayed the Prior Forecast product for the ATSC and noted that the forecasts are inconsistent. ATSC would like a high-rate GDP to support an AFP because the wind in NY will be favorable. There will be arrival rate issues in the 16Z to 18Z hours.	SA, AFP	
1245	Stake-holder	No	Webinar: The models are performing well today. ATCSCC is requesting CAN routes but the CCFP and CoSPA suggest that NavCanada may not be able to support this request; storms are forecasted for southern Ontario. MGM is also under consideration.	SA-R	
1315	Stake-holder	No	SPT: The stakeholder is looking at CoSPA and TFI for ZDC airspace (TFI FCA ZDC001). The CCFP has been updated and CAWS is out. No wind routes today. ATCSCC is hopeful NavCanada will approve the CAN routes but no decision yet. ZDC has stopped CLT internals arriving DC but should get traffic moving again soon. ZNY is monitoring the 15Z forecast for EWR; they may need a GDP for EWR. The stakeholder repeats that they would like a high rate GDP to control the spikes AFPs cause. ZTL said they were fine for now but may need help with routes later in day (referenced CoSPA).	SA, SA-R, COORDINATION	SA-TFI
1315	ZNY	No	SPT: Two east and two west CAN routes are approved.		
1325	ZOB	Yes	The STMC displayed TFI FCA ZNY001 and ZBW001 to "build" OB1. The STMC also tried to find an FCA that mirrors the ZOB/ZDC portion of OB1, but none exists. The STMC commented that TFI was referenced in the 7/13/2015 summary.		SA-TFI

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1337	Stake-holder	No	The forecast confidence envelope for TFI FCA ZNY001 is large this afternoon. The ATSC noted high uncertainty in all forecasts. The HRRR does not have a good handle on afternoon convection due to the dynamic conditions.		SA-TFI
1340	Stake-holder	Yes	The stakeholder used TFI and CoSPA forecasts for EWR to assess if a EWR GDP is needed.	SA	SA-TFI
1400	Stake-holder	Yes	This stakeholder uses TFI and COSPA to assess the NY airport at 4 hours and beyond. The user feels, based on the forecast, that AFPs are not warranted. They are currently determining which round-trip flights to cancel after the GDP is issued.	SA, SA-T	SA-TFI
1405	SCC	Yes	The SVRWX TMCs are discussing AFPs and are concerned about timing and rates (per ZOB phone call). TFI was displayed and the TMC used CoSPA 8-hr VIL and TFI overlays to discuss how to structure OB1 and A08. The timeline was used to discuss the start time of the AFP as well as how restrictive to set the rates.	AFP, COORDINATION	TFI-AFP
1422	ZOB	Yes	TFI timelines: ZNY001 Y3R5, ZBW001 Y2R6 (for 1515Z through 2215Z). Proposed AFPs: OB1 90/70/65/65/65/70/70/70/90/90 beginning 18Z, A08 100/95/90/90/85/85/90/95/95 beginning 18Z. Anything less than 90 is considered a HIGH impact for OB1. The proposed rates agree with time when TFI goes red. The STMC asked the observer to find an FCA that covered the ZOB/ZDC boundary; none exists.		SA-TFI
1430	Stake-holder	No	The stakeholder periodically brought the TFI window to the front to assess the product, but primarily uses the looping CoSPA forecast. TFI uncertainty remains large.	SA	SA-TFI
1431	Stake-holder	No	The dispatcher studies TFI for impacts to ZNY for situational awareness.		SA-TFI
1441	Stake-holder	No	The ATSC uses CoSPA and TFI to manage five flights; he is examining TFI and permeability for each route. The Duty Director visited the ATC desk and explained that all impacts must end on the same day or no later than 02AM the following morning. The timing is critical and they are using TFI to figure things out. The users see a gap that could be used for arrivals, but TFI does not distinguish between arrivals and departures.	ERP	TRI-R

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1500	Stake-holder	No	CoSPA is used to check the status of CAMRN. WSI Fusion weather updates every 5 minutes and uses PASSUR, which means it shows aircraft enroute and on the ground. AFPs have been issued.	SA	
1515	Stake-holder	No	SPT: GDPs are issued for EWR, LGA, and JFK. AFPs are still under consideration and a PHL GDP is being discussed. There are several reroutes for NY due to storms in southern NJ. A FL-to-NE route may be needed but a bigger problem is southbound flights out of NY. The stakeholder consulted CoSPA for ATL later today. An east-west line is forecasted to move south and approach ATL at 23Z and later which coincides with an arrival push. The stakeholder requested TFI FCAs for ATL.	SA	SA-TFI
1555	SCC	Yes	The observer shows SVRWX NTMO the TFI forecast for ZNY001A and B as well as ZBW gates through AFP regions. The NTMO is concerned over starting times of AFPs so the observer demonstrated the TFI timelines.		SA-TFI
1659	ZBW	No	The TMC looked at TFI to see the 8-hour forecast for the line of weather to the west.		SA-TFI
1730	Stake-holder	Yes	The stakeholder views TFI FCA ZNY001, watching the permeability decrease and assessing the error bars.		SA-TFI
1835	SCC	No	The observer was asked to analyze storm development in western PA using CoSPA/TFI to contribute to the discussion in SVRWX. The TMC liked the regions divided into arrival and departure gates (ZNY001 A and B) and requested similar FCAs for WHITE/WAVEY and J60/J64/Q480.	SA	SA-TFI
1901	Stake-holder	No	The TFI timelines are consulted for the ZNY region. "Pretty impressive."		SA-TFI
1905	Stake-holder	No	ATSC says TFI FCA ZBW001 shows excellent accuracy. The ATSC notes the JFK departure delays and references CIWS for situational awareness. Volume through A08 is a concern. It is very heavy for five hours, so a revision is possible. ATC is preferring LGA over JFK; aircraft are making a big loop into JFK and it is causing problems for the stakeholder.		SA-TFI

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
2048	SCC	No	Sidebar discussion with Terminal NTMO: When acting as Planner, this NTMO plans AFP rates that begin with low impact (high rates) and transition to higher impacts (low rates) then back to low impact. The NTMO reviewed TFI, which shows that ZOB impact would be high early then go to low impact. If he had planned the AFPS for today, he would have had too many planes at the start and not enough demand as the weather dissipates. He stated "The TFI plots allowed me to create an efficient AFP."		TFI-AFP
2212	Stake-holder	No	Dispatcher continues to use TFI to check on flights throughout the northeast. TFI is used for update messages to others in the SOC.	COORDINATION	SA-TFI
2240	Stake-holder	No	The observer conducted TFI training for a dispatcher who particularly likes the color-coded timelines. Another user asked about the weather at DCA based on CoSPA.	SA	
2251	Stake-holder	No	A pilot called the dispatcher for a briefing on the weather from Florida to the AR tracks and then up the coast. The dispatcher used the CoSPA and TFI 4-hour forecast and the captain decided to launch based on the information.	ERP	TFI-R
2315	Stake-holder	No	The observer conducted TFI training throughout the afternoon and evening. The most common request was to add FCAs for ATL. Another request was to be able to mouse over region and have the permeability graph pop-up. ATC is watching the line of weather approach ATL using CIWS/CoSPA	SA	

TABLE B-3

3 August 2015 Field Observations

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1050	Stake-holder	No	The ATSC was on duty when the observer arrived. The ATSC indicated that he really wanted to use TFI last week but could not get it to load. The observer indicated that there had been network problems. TFI is already displayed on the monitor today and ZJX is forecasted red with ZOB and ZDC yellow. There is convection out of radar range off the Carolina/DC coast so this may be a good case for OPC.		SA-TFI

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1109	Stake-holder	No	The ATSC consults TFI and tells the observer that ATCSCC will likely want an AFP today; probably OB1.		SA-TFI
1115	Stake-holder	No	SPT: ATSC displays TFI and looks at the forecast for Southeast US. The telecon planner indicates that an AFP for ZID and some Florida initiatives may be needed. They are expecting deep water route impacts for ZDC. ARs are ok for now. TPA is closed for lightning and level 6 storms. (The ATSC consults CIWS.) ZID indicates there is no significant weather between J6 and J80. N90 says all airports are in good configurations; LGA 22/13. EWR rate is 38, 40 and there is no overflow runway.		SA-TFI
1122	ZNY	No	There is lightning off the coast of the Carolinas. The observer demonstrated the TFI FCAs that appear to be appropriate for today are ZNY001 and ZNY001a, ZNY001B, and ZNY006, essentially providing TFI refresher training.		SA-TFI
1150	ZDC	Yes	TFI shows ZDC002 yellow at 1430Z for two hours. The STMC says "So, I'm not going to be impacted here until 1430Z."		SA-TFI
1215	ZOB	Yes	The STMC looked at ZJX003 FCA (R3Y2G2) to assess the product. FCAJX7 was issued to begin at 14Z and the STMC wanted to compare TFI to the AFP. The STMC looked at the evolution of the forecast and how that was reflected in TFI. "That's neat." The STMC then provided the CIC with a quick overview of TFI. The STMC was asked if he would be interested in OPC. He had no interest.		SA-TFI
1235	SCC	No	The Terminal NTMO asked to view TFI in order to aid SVRWX NTMO plan for 1245 webinar. There is a concern over TFI region not matching traditional AFPs. The TMC would like to at least see A05, A08, A06, OB1, A01, A02 and JX7 AFPs in addition to TFI FCA regions.		TFI-planning

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1245	SCC	No	TMCs are considering AFP JX7 for ZJX. The Planner is also considering A08 and OB1, so timing between ZJX and ZDC AFPs are an issue. All airlines feel that storm development will be very spotty and are arguing against AFP's today. NOTE: The TMCs have viewed TFI on their own. TFI showing green/yellow at worst across A08 and OB1. CoSPA has very few storms, while ZJX is only region displaying red/yellow TFI regions. The NAM is stressing high coverage (>60%) based on SREF/WRF models and suggesting AFPs are needed.	AFP	SA-TFI
1314	ZOB	No	ZNY001, ZBW001 (surrogate for OB1), ZOB002, Z0B003 (surrogate for A05) are all displayed. Impact is expected on ZOB003, ZNY001, and ZBW001. TFI shows all green except ZOB003 (G5Y3).		SA-TFI
1315	SCC	No	SPT: AFP JX7 is being issued to control ZDC/ZJX traffic flow. ZDC is currently pushing traffic flow west (inland) and ZJX is moving traffic east, thus creating a funnel effect in ZJX. TMCs are using TFI to gauge start/end time of JX7 and A08 in particular. The Planner states A08 and OB1 are on the Table but NO GDPs for today. ZOB is concerned with DC metros after 19Z so would be willing to consider AFPs.		TFI-AFP
1336	Stake-holder	No	The ATSC is viewing TFI for weather in the Southeast. He notes that the timeline for ZJX is yellow. He expects storms across the Northeast and AFPs and high-rate GDPs.		SA-TFI
1340	ZNY	No	ZNY001 and OB2 timelines are green at 2135Z.		SA-TFI
1346	SCC	No	The SVRWX planner is using TFI and CoSPA to view the forecast over ZOB/ZDC and ZJX. In particular, he is looking at transition points over BUGSY and MERTO in order to plan CAN route choices as offload for OB1; these need to be coordinated with NavCanada.	SA	TFI-R
1422	ZNY	No	The STMC checks the 0- to 8-hour forecasts (CIWS/CoSPA) and focuses on impacts at the N90 boundary. He says it looks like the north gates will be impacted.	SA-R, SA-T	
1436	Stake-holder	No	The observer conducted CIWS and CoSPA training. The user requested standardized configurations at each position so he does not have to design a configuration.		SA-TFI
1437	Stake-holder	No	The ATSC checked TFI and the 0- to 8-hour forecast for planning flights to/from ZNY.		SA-TFI
1450	ZDC	Yes	The observer conducted TFI training for the CWSU, who is very interested.		

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1600	Stake-holder	No	The ATC supervisor studied the TFI data for OB1 and mentioned that it was what he expected; showing very little impact and later. He felt that AFPs were not needed. They were also very unhappy about the use of A08 as it causes problems for traffic flow in the BWI which is very important.		SA-TFI (confirmed expectations)
1610	SCC	No	The SVRWX TMC inquiries about TFI over ZJX in order to make a decision on when to end JX7. The TMC also made some suggestions on potential TFI regions: SAV, CHS fixes in ZTL are main crossing points where they would like to have a TFI region, and along the border between ZTL and ZDC as well as ZID and ZDC (J6/BKW).		TFI-AFP
1710	Stake-holder	No	The replacement ATSC uses CoSPA with echo tops tags.	SA	
1715	ZOB	No	SPT: The STMC studied TFI and then opened HRRR from Next Generation Weather Lab website. ZDC002 R2Y2G4. VUZ and MGM are being changed. ZOB reports that the plan is good.		SA-TFI
1721	Stake-holder	No	The ATSC used TFI to determine the status of ZDC002 and approves of the color-coding.		SA-TFI
1800	SCC	No	The SVRWX TMC using CoSPA and TFI to analyze current AFPs and for potential revision. The TMC is being asked if the rates (especially OB1) should be reduced due to a volume spike in 21-23 block. Based on TFI, the TMC is leaning towards leaving the AFP rates as is. The forecast is for storms to remain scattered so extra volume in those two or three time periods can be managed without the need for revision.	SA	TFI-AFP
1800	ZOB	No	The STMC opened TFI and displayed the FCAs corresponding to OB1 and A08. TFI shows some yellows, but no significant impact.		SA-TFI
1830	Stake-holder	No	Stakeholders are using ITWS, CoSPA, and CIWS for situational awareness and hand-off briefing. The observer conducted training on TFI.	SA	
1910	ZDC	Yea	The STMC displayed CoSPA.	SA	
2053	Stake-holder	No	ATSC uses CoSPA to try to determine why the weather never developed as anticipated.	SA	

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
2115	Stake-holder	No	SPT: ATSC continues to use CoSPA throughout the SPT/ Models show little change in demand for AFP rates. Everyone agrees that the AFPs can be canceled. MGM and VUZ are canceled. PHLYER N, S, and W are still active. ZNY is single stream on north gates, ZDC is opening coastal airspace. ZJX says AR routes are good. ZBW reports a nice line of weather from south of ALB to Canada. N09 say there is excess demand at LGA and thunderstorms are possible after 23Z. PHL AAR is 44 with a spike at 23Z; metering. ZOB was the DTW to BOS traffic has been moved north to avoid weather. There are lots of reroutes for NY traffic. They will remain tactical for the 22Z hour.	SA	

TABLE B-4

20 August 2015 Field Observations

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1035	SCC	No	A4A is using CoSPA and evaluating TFI for long range potential AFPs. The Planner is using CIWS to brief NTMO-Term. There is only one NTMO to cover both Term and SVRW.	AFP	TFI-AFP

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1050	Stake-holder	No	The ATSC said that it was going to be a rough day and he did not know how traffic was going to get out of New York. ZDC had concerns; J121 was stopped, along with WHITE-WAVEY and departure gates, including the west gates. TFI was running on Chrome at the ATSC workstation and the timelines had been reviewed prior to the arrival of the observer. The plot for ZNY003 and ZDC003 showed worsening flow through about 1900Z. There was high impact at the end of the plot and it was continuing to drop. TFI showed about 40% of normal flow getting through so the ATSC thought low rate AFPs would be needed. He also said that CAN routes may not be possible (based on CoSPA). The TFI timelines and new CoSPA - AFP overlays were demonstrated. The observer asked if ATSC would like TFI on the stand-alone display. ATSC indicated that it would be nice, but not really needed. He prefers to have a 2-hour tactical loop from CIWS on the stand-alone, and a longer range 8-hour strategic forecast on a browser directly in front of him.	AFP, ERP	TFI-AFP
1100	ZOB	Yes	The observer reviewed TFI, CoSPA, and Prior Forecast with the STMC. The observer noticed slow browser performance and was told that this was normal for their internet. The STMC looked at the TFI timeline for ZOB and noted that it did not look bad. The observer reminded the STMC to look at the ZNY FCAs for the area along the ZOB/ZNY boundary and at ZBW FCAs for the area between ZOB and ZBW. The STMC would like the ZOB/ZNY boundary in the ZOB timelines. Looking at ZOB timelines only, TFI indicated minimal impact for the day, but the ZNY and ZBW showed a much worse event, with many times showing red impact along the boundaries after 1730Z. (OB1 looks like a good fit today.) Prior Forecast shows consistency across model runs, but ATC could use a 12-hr forecast to see beyond 22Z.	SA	SA-TFI
1105	SCC	No	The Planner would like to see actual flow rates vs only permeability on TFI product. Permeability is "ok" but the Planner would like to have direct translation to flow rate based on the AFP being considered. TFI is used to evaluate timing of AFPs with the Planner. The Planner asked to view TFI regions over ZNY/ZBW/ZDC; is interested in timing with rate/intensity as well.		TFI-Planning

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1112	ZOB	Yes	The observer and STMC discussed the current situation and the observer demonstrated how to display the permeability plot. The observer noticed that the uncertainty for ZNY0011 was large but prior forecast looked consistent. The CWSU visited the TMU prior to the 1115Z SPT and informed the STMC that thunderstorms would develop after 1500Z.		SA-TFI
1113	Stake-holder	No	Conditions in the Northeast are expected to worsen after lunchtime and impacts will be felt on the routes. ATSC shows another person the 0- to 8-hour forecast for the Northeast using the TFI timelines and the weather graphics.		SA-TFI
1115	ZOB	No	SPT: ZNY already has departure delays. CAWS 1,2 and 3 are out with 1 and 2 concerning storms in Gulf. CAWS 3 has storms developing in W PA between 15Z and 17Z. CCFP shows a forecast for a challenging day with moderate coverage west of N90 by 17Z. AR routes are closed both directions except for DC Metros, and VCAPES are active today. ATCSCC stated that AFPs were on the Table today with routes closing and GDPs starting by 15Z for N90 metros. L455 is closed; there are showers in SW ZNY and these are causing delays already. J75 and J6 are closed. ZOB is having problems getting to ZBW due to storms in western NY. There is a sigmet for these storms with tops below 30 kft and only embedded level 3. In fact, all storms are weak this morning. The STMC spent most of the time during the SPT studying CAWS/CCFP but did glance back at CoSPA and CIWS on the stand-alone. The TMC commented that he would like CoSPA/TFI on the stand-alone and how important the stand-alone was for day-to-day work; they really need a good stand-alone weather display.	SA	
1142	Stake-holder	No	GDPs are issued before AFPs. The TFI FCA ZDC003 was displayed and options were discussed, but nothing looks good. TFI forecasts high impact at 1800Z. Without a plan, this could be a possible run-to-failure day. J6, J75, and WHITE-WAVEY are closed. East coast flights are being rerouted. One user feels ATCSCC is overdoing things already. A Dispatcher visiting ATC said he loves CIWS and CoSPA and that they are some of his favorite weather tools.		SA-TFI

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1150	ZOB	No	The STMC received a call about AFPs. They were told earlier there would be no webinar to discuss the weather. While on the call, the STMC looked at CoSPA and TFI and the ZNY001 FCA. He added the A01, A02, and OB1 COSPA overlays as well. The TMC printed copies of the FCAs but OB1 was not printed and the TMC was not sure what it looked like. The STMC said that they were planning a A01 and A02 at a high rate starting at 17Z. However the TMC at the CP was also on a telcon with ZDC and he said they were going to run OB1 and A08.	SA	SA-TFI
1208	ZOB	Yes	The observer noted relatively large uncertainty bounds for ZNY001; larger than expected given the fairly consistent forecasts being shown in Prior Forecast. TFI still indicates a start-of-impact time of 17Z and red by 18Z. ZOB requested TFI FCA for the boundary with ZDC and ZID.		SA-TFI
1236	ZOB	Yes	The STMC indicates that there was a decision to run A08 and OB1 with a high rate. The STMC did not discuss A01 over OB1 or the use of GDPs only. The TMC that originally felt only BW1 was needed has changed his mind and now agrees with the OB1 and A08. The STMC provided a chart with the proposed rates for OB1 high impact is 80-90 per hour down from 120. That is only a 75% to 67% reduction in traffic while TFI shows they will only have about 40% permeability.		SA-TFI
1255	SCC	No	The Planner asked the observer to show SVRWX TFI plots in order to evaluate timing and rates of proposed AFPs. NOTE: Planner would like to have CoSPA/TFI/CIWS/OPC all on one stand-alone.		SA-TFI
1328	ZOB	No	After the handoff, the new STMC displayed TFI immediately after logging in without prompting from the observer. He used the page to look at the AFP locations and forecast of storms and then looked at the charts for OB1 and AFPs in ZDC.		SA-TFI
1328	ZDC	No	The TFI FCA ZDC003 shows red-yellow-red for the 6-, 7-, and 8-hr forecasts.		SA-TFI
1353	Stake-holder	No	AFP proposal telecon (ATCSCC). High Impact Day with A08 and OB1. OB1 - 1700Z to 0459Z. 85 rate to start with and 75 at 2100Z. 85 at 0000Z. Avg delay of 91 min with a max delay of 171. A08 from 1700Z to 0159Z. 1700Z - 75, 2000Z - 80, 2100Z - 85. 39 min avg delay. NBAA asks about a possible east CAN to ZBW (as a route-out option for Boston).		

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1459	Stake-holder	No	A dispatcher came into the ATC section and said he is using the TFI tool right now because it is the only way he can figure things out. He came in to speak with a crew scheduler.		SA-TFI
1502	Stake-holder	No	ATSC is using TFI. He has ZDC003 displayed and is checking Flight Explorer for his flights. He did not use the plots, just the graphics.		SA-TFI
1515	SCC	No	SPT: The Terminal TMC references TFI to plan GDPs and is utilizing both CIWS/CoSPA in tactical/strategic look at deterministic VIL. TMC then adds TFI regions leading into/out of N90 in order to identify how much airspace will be restricted upon departure. Canadians are concerned with eastbound route-outs. CCFP shows storms possible on this route. SVRWX TMC references SREF/CoSPA/TFI as guidance for GDP/AFP combination. GDPs/AFPs, CANs and VUZ are all published at this point. L453 is closed but pathfinders are on the way. SSM4 CAN route has been changed to Chico WEST Rubki has been changed to ALEUTO offload.	SA, GDP, AFP, Coordination, ERP, SA-R	TFI-GDP
1530	ZBW	Yes	The STMC wants to see TFI. He is impressed with the forecast and how it is displaying a long event for the day. He immediately knows that ZNY001 and ZBW001 are the areas that he wants to see because that is where the weather will be. He agrees with what it is showing for permeability (40-50%) given the weather situation. The STMC does not need the TFI FCAs to match the geographic areas/sectors that they use. He understands that the TFI FCAs are where they are for a reason. He is also not interested in FCAs to northern New England as the CWSU was because he says there is plenty of room to fly around up there. In contrast, the CWSU would like to have FCAs for northern New England.		SA-TFI

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1535	SCC	No	The observer demonstrated TFI to the NOM for evaluation. The NOM feels TFI could have been very useful today for planning and that the TFI rates on ZNY001/ZBW001 were accurate for today. He thinks that current rates on OB1 and A08 are set too high. All N90 airports are ground stopped with concerns about gridlock at LGA. The NOM would have liked to have used TFI rates (or rates closer to permeability) but could not get "buy-in" from customers. MIT LL needs to prove accuracy on rates; rates are needed. Case studies on summer days with proof need to be shown to airlines to "get them on-board" with TFI.		SA-TFI
1543	Stake-holder	No	Someone stepped into ATC and had questions about routes between FLL and RIC. CoSPA and TFI were used to show that there should not be problems in Florida.	SA	SA-TFI
1545	UAL	No	The biggest problem for stakeholder is HOU. CoSPA displayed and used. No TFI or OPC.	SA	
1635	Stake-holder	No	ATSC is viewing TFI and the colored timelines for conditions across the east. Only ZOB and ZDC are yellow, not red.		SA-TFI
1751	SCC	No	The NAM indicates that storms will begin to diminish at or after 01Z. Therefore SVRWX will shorten AFP end times and raise the rates. SVRWX evaluated TFI for concurrence; viewing not only color-coded time-lines but initiated plots of ZNY001/ZDC002 and ZBW001.		TFI-AFP

Time (UTC)	Facility	Observer Assist	Observation	CoSPA Benefit	TFI Benefit
1915	Stake-holder	No	SPT: AFPs were revised to slow the demand, but more might be needed. CAN E (to avoid OB1) is required. GREKI 1/2 are also required. Boston to DC have no routes available. Waiting for VACAPES to open. Someone questions if west and south gates are closed. ZNY says north and west gates are closed except for GAYEL and GREKI. GREKI may be the only gate that remains open; 20MIT. AZEZU is closed. ZDC says internals are still on the grid. LIMBO is open west, waiting for military operations to end. A stakeholder is concerned about PHL. They are in a 2nd tier stop including Canada. ZJX is having trouble on the east coast, military operations are all hot. ZJX can open the AR routes. ZOB says there is weather on the eastern boundary of the Center. GREKI route was lost and there are lots of deviations to New York. The ATSC uses CoSPA during the SPT (on the TFI website). LGA, EWR, and PHL. JFK is OK, but things are getting worse with no routes available. PHL is parked all over the airport.	SA	
1915	SCC	No	SPT: AFPs are revised with A08 extended two hours; average delay increase from 17 min avg to 134 min. The Planner used CIWS/CoSPA to brief during SPT.	SA	
2021	ZDC	No	Stop all OTTO/RAMAY. The observer launched CoSPA for the STMC because TSD weather is DOWN.	SA	

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APPENDIX C.
ADDITIONAL CASE STUDIES

IMPROVED AFP EXECUTION, MANAGEMENT, AND COORDINATION (13 JULY 2015)

Twenty-two individual benefit entries were noted on this first observation day of the season, many of those originating from the airline operation centers. The airlines play an essentially symbiotic role in the strategic planning process with the FAA. Air Traffic Flow Management needs to understand the scheduled demand of the day in order to properly plan TMIs and the airlines need to know those TMIs in order to plan origin-destination (O-D) pairs, potential Estimated Departure Clearance Times (EDCT) and reroutes to fit their business strategy. Therefore, industry's understanding and involvement in the daily strategic planning process is paramount, and this is why MIT LL observers visit and record notes at various airline operation centers in addition to FAA facilities.

The first observed example of operational use of CoSPA and TFI was recorded at the JetBlue Systems Operation Control Center on 13 July 2015 where current and forecast TFI permeability was sent (via internal chat) to all JetBlue work centers and dispatchers. Throughout the morning, JetBlue Air Traffic Management (ATM) participated in the two-hourly SPTs and referred to TFI information as strategic plans were mapped out for the day (Figure C-1).

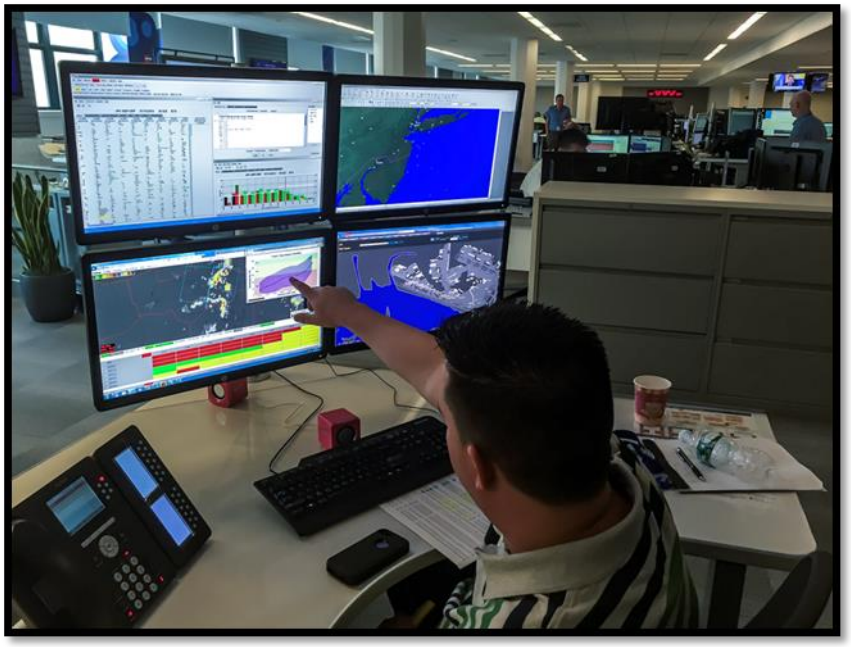

Figure C-1. JetBlue air traffic manager referencing the TFI application on 13 July 2015 at the JetBlue Systems Operation Control Center.

At 1235Z, immediately following a national telecon involving all airlines, a JetBlue air traffic manager said that "Based on the TFI tool, AFPs will be needed to slow the traffic down across ZOB and ZDC. The terminals will be fine." JetBlue managers viewed CoSPA and TFI later in the hour and agreed with the low rates proposed in the AFPs by ATCSCC. There was extensive use of TFI to check the permeability forecast through ZOB airspace during these discussions. Rates for AFPs A01 and DC4 (Figure C-2) were finalized and issued by 1645Z.

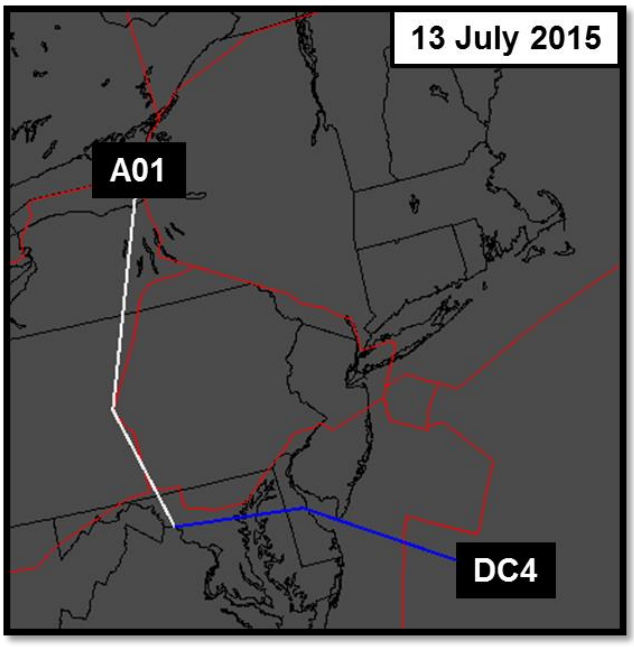

Figure C-2. Airspace Flow Program boundaries issued to control air traffic in-bound to the New York region on 13 July 2015.

JetBlue ATM continually monitored development of the weather as well as air traffic delays over the next several hours. JetBlue ATM viewed their internal Flight Schedule Manager (FSM) bar graph (Figure C-3), which tracks both the number of aircraft passing northward through the DC4 boundary and the projected demand through this airspace several hours into the future. JetBlue ATM attempted to correlate the actual demand forecast with a TFI region; in this case ZDC002 which lies across the eastern Carolinas (Figure C-4).

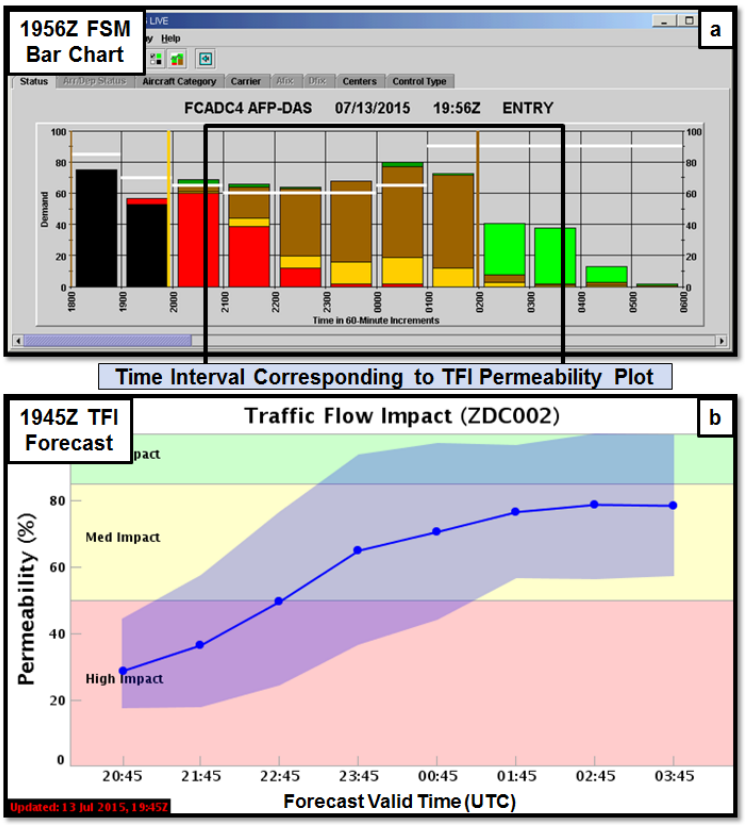

Figure C-3. Plot of JetBlue 1956Z Flight Schedule Manager for AFP DC4 (a) and 1945Z TFI permeability and confidence plot on 13 July 2015.

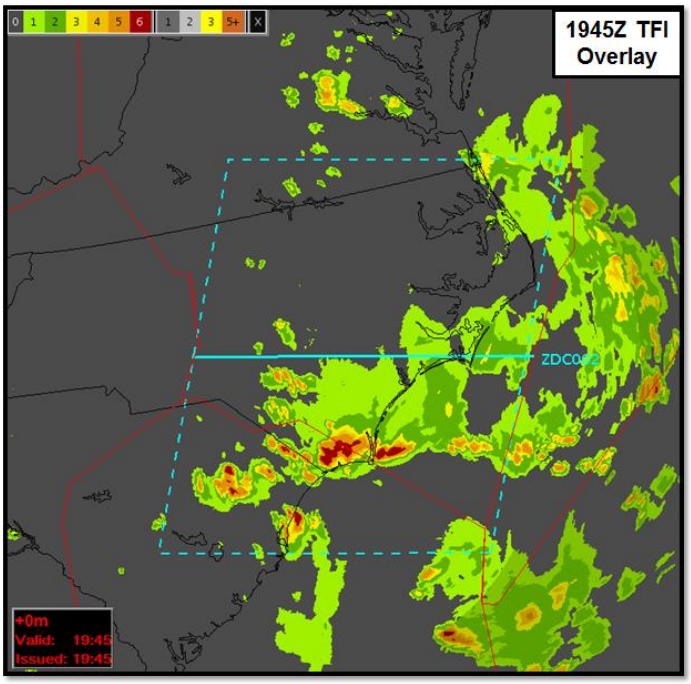

Figure C-4. The CoSPA VIL and associated TFI overlay of ZDC002 on 13 July 2015 at 1945Z.

The following is a synopsis of the traffic managers' comments regarding this comparison.

- TFI roughly corresponded to the posted rates in the FSM window in that the rates were lower for the periods of expected impact. However, if only 30 percent of the flights were projected to be able to pass through the airspace in the 2000Z hour, the rate was too high. The JetBlue manager stated that he did not see that reflected in operations.

- If the rate was actually too high, JetBlue would see enroute holding and significant deviations and reroutes. This was not occurring.

- The rates in the FSM window were sufficient to manage the traffic. If they were lower, the airspace would have been underutilized.

JetBlue ATM was using TFI to gauge if current AFP rates were set correctly and to decide whether those rates needed to be adjusted based on the current TFI forecast. In this example, the manager determined that the TFI forecast of thirty-percent permeability was too low based on the current demand and throughput observed. Coordination and Improved AFP Management (AFP) were exhibited during this first day of observations.

IMPROVED TMI PLANNING AND COORDINATION (20 AUGUST 2015)

The third and final observation occurred on the 20th of August and utilized all previous FAA facilities in addition to JetBlue and United Airlines. Six direct references to TFI at ATCSCC were noted during the strategic planning period. TFI was evaluated during the AFP planning process to determine timing and severity of the TMI needed. One observation attributed to a terminal traffic manager in the 4- to 6-hour timeframe noted use of TFI to plan a potential GDP prior to the AFP issuance. This terminal specialist utilized TFI to more precisely identify three key pieces of information about the event, similar to observations taken on the previous operational visit (3 August 2015):

1. **Onset**: When to start the GDP and decrease airport arrival rates

2. **Duration**: When to increase the GDP rate to nominal levels

3. **Severity**: How to determine the GDP rate structure

Figure C-5a highlights the 1300Z 8-hour CoSPA VIL forecast, which was evaluated in conjunction with TFI for this specific hour. The NOM on duty at ATCSCC agreed that TFI "could have been very useful for planning, considering the accuracy in the forecast displayed today." The 8-hour deterministic CoSPA forecast and the probabilistic CCFP were in agreement on this day, which added to the confidence in the forecast. Timing, shape, coverage and intensity of the storms were all highly correlated (Figure C-5a) as compared to the truth VIL (Figure C-5b). Several SPT conversations throughout the morning discussed rates of the proposed AFPs (OB1 & A08) with consensus settling on approximately a 35-40% reduction of throughput across each AFP. Guidance from TFI (Figure C-6) suggested a moderate to high impact event and the potential loss of up to 65% of the throughput in the OB1 region. After the strategic planning was complete that morning the NOM deduced that "current AFP rates are set too high". He was concerned that the rates which were agreed upon by FAA facilities and airlines during the morning conferences were not going to be impactful enough based on the coverage and intensity of the thunderstorms he was witnessing. He reasoned that the rates TFI was suggesting in the morning may have been more representative of the reduction needed to restrict traffic. Figure C-6 displays the 1300Z TFI forecast (blue plot) along with the actual permeability verification (black plot) for the TFI region ZNY001 which represents AFP OB1. Although the actual loss of throughput was not as severe as originally forecast, TFI's indication that the event would require more than the issued 35-40% reduction was correct. Multiple ground stops for all NY terminals were issued on this day which is often indicative of over-delivery of demand based on restrictions due to convective weather.

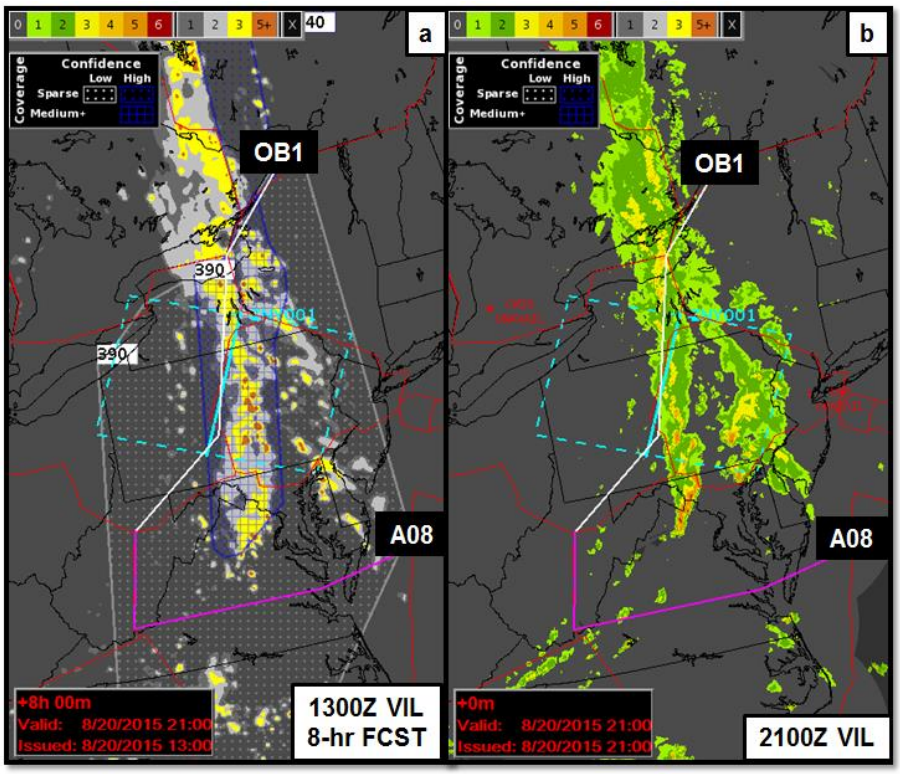

Figure C-5. (a) The CoSPA VIL and CCFP 8-hour forecasts and (b) the 2100Z VIL truth on 20 August 2015. Shown in the plots are AFPs OB1 and A08, along with the TFI region ZNY001(in cyan) highlighting the restricted airspace due to thunderstorms.

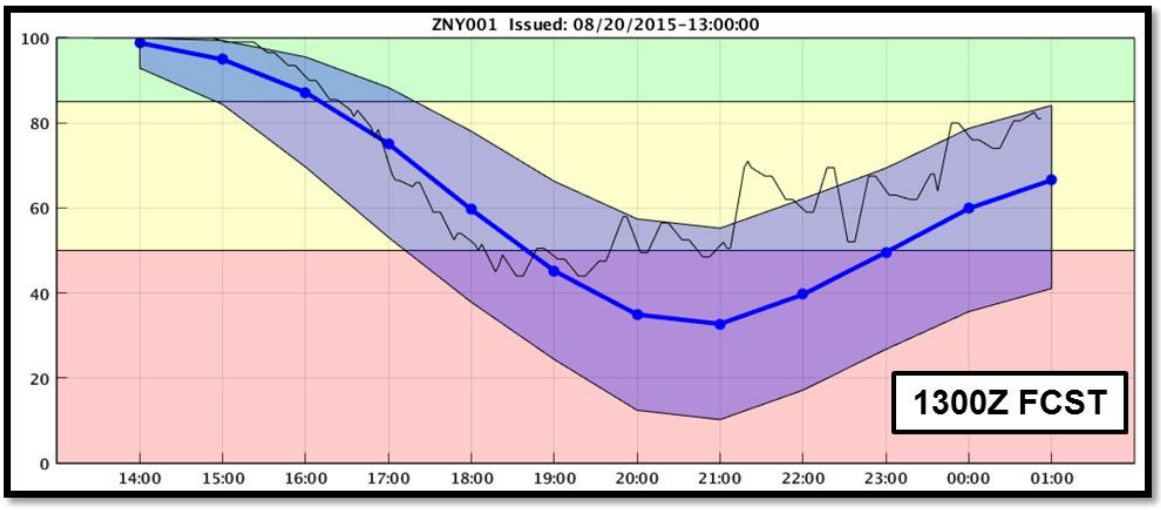

Figure C-6. The 1300Z TFI forecast (solid blue line) and verification plot (black) on 20 August 2015 for the ZNY001 region representing AFP OB1. Also shown is the forecast confidence (shaded blue region) which highlights the 20th and 80th percentile (lower and upper bound respectively).

APPENDIX D.
USER REQUESTS FROM FIELD OBSERVATIONS

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
SVRWX NTMO would like to add TFI regions for ORD, ATL, DFW, and HOU, and one for HOU over Louisiana along the AR/TN border to control/monitor flow in/out of MEM.	X									
The observer conducted TFI training and demonstrated the Prior Forecast product. The ATSC would like other Centers added to the timelines and more regions to cover Atlantic and Deep Water routes.	X									
The SVRWX TMC was encouraged by the observer to look at the TFI product. The TMC asked to have the TFI FCAs explained. This TMC would like to see smaller and more FCAs in ZID/ZDC to cover the airspace into and out of ZDC (near BKW).	X									
The observer conducted TFI training. The user would like TFI regions added in VT/NH for more northern coverage. If storms are in NJ/NY, they like to bring planes in north over Kennebunk.	X									
The observer conducted TFI training throughout the afternoon and evening. The most common request was to add FCAs for ATL. Another request was to be able to mouse over region and have the permeability graph pop-up. ATC is watching the line of weather approach ATL using CIWS/CoSPA	X				X					

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
The observer was asked to analyze storm development in western PA using CoSPA/TFI to contribute to the discussion in SVRWX. The TMC liked the regions divided into arrival and departure gates (ZNY001 A and B) and requested similar TFIs for WHITE/WAVEY and J60/J64/Q480.	X									
SPT: GDPs are issued for EWR, LGA, and JFK. AFPs are still under consideration and a PHL GDP is being discussed. There are several reroutes for NY due to storms in southern NJ. A FL-to-NE route may be needed but a bigger problem is southbound flights out of NY. The stakeholder consulted CoSPA for ATL later today. An east-west line is forecasted to move south and approach ATL at 23Z and later which coincides with an arrival push. The stakeholder requested TFI FCAs for ATL.	X									

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
The observer arrived at ZOB and conducted TFI training for the STMC who had not seen TFI before. The STMC was very excited about the product and plans to use it all the time. The observer demonstrated the FCA selection and talked about how TFI FCAs are different from standard AFPs. ZOB003 and ZOB002 cover most of A05; the ZID/ZOB boundary portion is missing. The STMC commented that Q29 passes through ZID/ZOB border and carries significant traffic to ZBW. He suggests an FCA oriented perpendicular to Q29. He would also like an FCA for ZOB/ZDC boundary, but Q29 is the priority. In general, ZOB prefers routes to AFPs; moving traffic rather than slowing it. The STMC comments that the 19Z hour is the heaviest for NY traffic through ZOB. When discussing forecast confidence, he commented that when the forecasts are inconsistent (big changes between updates) the weather intensity and impact tends to be worse.	X	X								
The SVRWX TMC inquires about TFI over ZJX in order to make a decision on when to end JX7. The TMC also made some suggestions on potential TFI regions: SAV, CHS fixes in ZTL are main crossing points where they would like to have a TFI region, and along the border between ZTL and ZDC as well as ZID and ZDC (J6/BKW)	X									
The observer demonstrates TFI to the STMC. The STMC suggests adjusTable TFI timeline panel (like RAPT).										X

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
The user asks the following questions concerning TFI: Is there a way to change the color of the TFI overlays (currently cyan)? Is there a way to quickly view each permeability plot? How will this stakeholder know which TFI regions ATCSCC is viewing? Can FCAs be drawn dynamically?				X	X					X (2)
ATC desk user said it is difficult to match TFI FCAs to AFP regions, even if TFI FCAs relate better to traffic. This user request the capability to draw FCAs or click an FCA and have the TFI permeability displayed. It is difficult to display TFI in the current state. The observer notes that TFI error bars have been very wide today. The webinar continues and stakeholders think the rates are too low. ATCSCC was asked if the AFPs could be divided into smaller areas.				X	X					
ATSC asks the meteorologist about the possibility of fog at Logan at 2000Z. It is early, but will it persist? AFPs: DC4 at 65 rate for 1900Z - 2000Z. There is confusion trying to correlate permeability with an actual rate. Highest impact does not equate to the lowest rate. Currently, 63 is a nominal rate based on the TFI. The TFI is too aggressive. One third of 90 is 30, but the rate is too aggressive. ATSC wants TFI regions to map directly to the AFPs and flow rate numbers assigned to each plot point. There's a bow echo in KY that is pushing traffic east into all TFI regions. ATSC asks if the permeability % is the percent that will get through or not get through.		X				X				X

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
Traffic managers suggest new tool idea: "what happens to a route when you move a flow to it?" Traffic all moved to J75 - overflowing!										X
CoSPA is not being used at all in TMU. The large monitor at the TMO position shows CIWS; the observer will coordinate with the STMC to show TFI on monitor. One user wants RAPT back on screen and CoSPA returned to SD. Web is not used.							X			
The observer conducted TFI training for some TMCs; they would like to see TFI by sector like the high/medium/low sectors on ESC-64.			X							

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
The observer demonstrated TFI to the STMC. The observer worked with STMC to find FCAs that were like A08 and A05. ZOB002 (ZAU boundary) and ZOB003 (ZID boundary) capture the east/west flows of A08, but there is no FCA that corresponds to the N/S section of ZOB/ZID. Also, there is no FCA that corresponds to A08. ZDC001 is closest to the E/W section within ZDC, but nothing captures the Beckley (BKW/J42) traffic that crosses the N/S boundary of ZID/ZDC. The observer displayed the TFI windows for ZOB002 (ZAU boundary), ZOB003, and ZDC001. Noted ZOB002 (the ZAU/ZOB part of A05) was R5Y3 (1145Z). ZOB002 permeability goes from 10% to 60% from 1245Z to 1945Z, reaching 50%@1745Z; ZOB003 is G6Y2. ZDC001 is Y3G2Y3. The observer offered to demonstrate TFI to another STMC. The STMC was very busy so training was worked in between interruptions. The observer noted that since ATCSCC was considering AFPs, it might be worth looking at TFI.		X								
The SVRWX TMC uses CosPA and TFI to evaluate storms that are expected to develop. A request was made for a TFI forecast out to and beyond 12 hours and for a percent score for the confidence/accuracy of the forecast, similar to CIWS.								X		X
A pilot called the dispatcher for a briefing on the weather from Florida to the AR tracks and then up the coast. The dispatcher used the CoSPA and TFI 4-hour forecast and the captain decided to launch based on the information.										X

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
The STMC displayed TFI FCA ZNY001 and ZBW001 to "build" OB1. The STMC also tried to find an FCA that mirrors the ZOB/ZDC portion of OB1, but none exists. The STMC commented that TFI was referenced in the 7/13/2015 summary.		X								
The observer conducted TFI training. The user requested the capability to mouse-over a region and have a box pop up.					X					
In a comment from a stakeholder that was published in the 7/13/2015 summary, TFI was used as evidence that the rates chosen for the 7/13 AFPs were not optimal. "It would have been nice to know what a translational tool like this would have predicted."						X				
The observer discussed with the SVRWX TMC improvements to TFI that attempt to evaluate flows base on sectors. The TMC did not suggest individual sector impacts, but possibly a group of sectors, depending on where the storms develop, in order to evaluate a specific flow.			X							
Suggestion: There should be an indication that some, but not all, TFI FCA regions are selected. Currently, when all for a particular Center are selected, there is a check in the checkbox on the timeline. If fewer than all are selected, there is no indicator.										X

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
SPT: The CCFP shows forecast convection should slowly start to decline. CIWS was referenced on SPT for oceanic routes. ATCSCC says AFP08 may be revised because of heavy traffic in about an hour to reduce demand during the peak but ZDC says to let it run as long as possible. (NOTE: CoSPA appears to be doing very well today on the forecast; it showed much less convection during the afternoon.) The stakeholder has been watching the 23Z-00Z timeframe with a line forming to north of Atlanta. CoSPA forecasted this line 8 hours in advance. ZOB is doing ok so far. ZID talked about weather moving south and east. ZTL says routes are working OK today. BOS GDP was revised up; and all NYC GDPs were also revised up. (NOTE: User would like the TFI FCAs to match AFPs.)		X								
The observer conducted CIWS and CoSPA training and answered ITWS questions. The users suggested changes to TFI. The requested standard configurations for a number of airports and they want drill-down menus with pop-up options. They are interested in merging CIWS/CoSPA weather information into the new Dispatch Weather Route Tool (NASA). Observer note: DWR (Dynamic Weather Routing) works only enroute now, but if it could include CIWS/CoSPA forecast, it would help manage arrival times.					X				X	

Comment	More FCAs	FCAs Matched to AFPs	FCAs Matched to Sectors	Dynamic FCAs	Quick Access to Permeability Plot	Permeability Converted to Rate	Available on Stand-alone	12+-hour Forecast	Merged with other Products	Other
ATSC asked if there was a way to shrink the TFI timeline section only. (No) This ATSC prefers the colored timelines over the permeability plots because the timelines are immediately available and are more in line with the other tools she uses. This user wants (a) the TFI FCAs to exactly match the FAA AFPs to reduce confusion, and (b) the nominal AFP rate and the actual rate displayed on the timeline.		X				X				X
The observer conducted training for replacement STMC. This STMC suggested that TFI be computed for Areas or Sectors. (This may be a future product concept. He is looking for a sector monitor approach to the product.) He thinks TFI is beneficial as is but wants to see how it plays out with traffic flows. The observer indicated that this product does not use live traffic inputs. The STMC also suggested being able to draw polygons on the fly.			X	X						
The observer conducted CIWS and CoSPA training. The user requested standardized configurations at each position so he does not have to design a configuration.										X
The observer asked if a trend indication for the TFI product would be useful. The STMC stated, "Then we could know if it looks like it's getting worse." He suggested using the old color "so you know what it was last time."										X
The Terminal NTMO asked to view TFI in order to aid SVRWX NTMO plan for 1245 webinar. There is a concern over TFI region not matching traditional AFPs. The TMC would like to at least see A05, A08, A06, OB1, A01, A02 and JX7 AFPs in addition to TFI FCA regions.		X								
Use TFI with traffic as a metering tool for sectors.			X						X	

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APPENDIX E.
SURVEYS

Stakeholder 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		
2. I was adequately trained on the use of the tool.							X	Remembers being trained	
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X	The TFI colors in the timelines resemble RAPT colors, which is good.	
5. The timeline display color coding accurately portrayed forecasted weather impacts.								Does not remember	
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.							X		
7. It was easy to understand the notion of "permeability".							X		
8. The breakdown of low/med/high impact was helpful.							X		
9. The low/med/high impact cutoffs were accurate.								Unknown	

Stakeholder 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
10. The presentation of forecast uncertainty was helpful.							X		
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.							X		
12. The tool was helpful in facilitating discussions with other stakeholder.							X		

Stakeholder 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		
2. I was adequately trained on the use of the tool.								Not trained in the spring.	
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		
5. The timeline display color coding accurately portrayed forecasted weather impacts.								Unknown	

Stakeholder 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.							X		
7. It was easy to understand the notion of "permeability".							X		
8. The breakdown of low/med/high impact was helpful.							X		
9. The low/med/high impact cutoffs were accurate.					X				
10. The presentation of forecast uncertainty was helpful.							X		
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.					X				
12. The tool was helpful in facilitating discussions with other stakeholder.					X				

Stakeholder 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		
2. I was adequately trained on the use of the tool.					X				

Stakeholder 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.					X				
5. The timeline display color coding accurately portrayed forecasted weather impacts.					X				
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.									
7. It was easy to understand the notion of "permeability".						X			
8. The breakdown of low/med/high impact was helpful.							X		
9. The low/med/high impact cutoffs were accurate.					X				
10. The presentation of forecast uncertainty was helpful.									
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.						X			Wants TFI regions to correspond to FAA AFP locations
12. The tool was helpful in facilitating discussions with other stakeholder.									

Stakeholder 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.						X			Wants the ability to customize the colors of various TFI region overlays
2. I was adequately trained on the use of the tool.				X				Did not attend training in Spring but learned how to use TFI through real-time use.	
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.						X			• Wants the ability to set 15-min TFI time bins to correspond to 15-min time bins in FSM. • It is confusing which sectors apply to which ARTCCs. • Wants the ability to custom make sectors/areas/regions. • Wants the TFI regions to align with FAA AFPs.
5. The timeline display color coding accurately portrayed forecasted weather impacts.						X			
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.			X						
7. It was easy to understand the notion of "permeability".			X						

Stakeholder 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
8. The breakdown of low/med/high impact was helpful.				X					
9. The low/med/high impact cutoffs were accurate.					X				
10. The presentation of forecast uncertainty was helpful.						X			

Stakeholder 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.						X			• Overall, TFI has been a positive experience and great to use. • The 2015 SWAP season was one of the easiest in recent memory (meaning not as much or intense convection in the wrong places). • Wants SCC AFP rates included in the TFI plot or timeline (for reference). • TFI is more helpful for internal coordination than for external discussions. • Wants ZMA included next year. • Wants ZAU included next year • Wants ZFW included next year.

Stakeholder 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
12. The tool was helpful in facilitating discussions with other stakeholder.					X				• Fix the current ZNY001 overlay because it doesn't capture the actual flow. • Expand ZBW areas beyond the Boston area, and include airspace between ZBW and ZOB.

ZDC 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.					X			• User would like to be able to make his own polygons, and said that 25-30 polygons across the ZDC airspace would get him 100% coverage (to fully predict all ZDC routes) • Website-only access hamstrings the user; needs it on stand-alone	User loves the CIWS standalone SD; it's very useful to him to have it always running and easily visible. He thinks TFI is well-developed, but it doesn't work as-is for the way the ZDC airspace operates. It mimics traffic, but doesn't mimic the typically path of weather through the ZDC airspace. Referring to the Prior Forecast product, he notes that we miss weather relevant to ZDC by not providing a South Carolina region.
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X	• Fonts too large • Smaller footprint	• SelecTable colors for individual flows • Likes the color palette
5. The timeline display color coding accurately portrayed forecasted weather impacts.		X						TFI sometimes over-forecasts the intensity of the impact.	

ZDC 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.							X		• 10% coverage can be dramatic in New England • Rainbow instead of Low/Med/High. Blending of colors across impact categories could be easier to read.
7. It was easy to understand the notion of "permeability".							X	User would like light grey vertical grid lines (for hours) on the permeability plots.	
8. The breakdown of low/med/high impact was helpful.	X							• Little repetitive; Low/Med/High are self-explanatory, the label "Impact" is not needed. • Not dynamic • What's high impact in one does not equal high on another • Shrink green columns width	
9. The low/med/high impact cutoffs were accurate.	X							Should be regional	
10. The presentation of forecast uncertainty was helpful.							X		
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.				X				Room for improvement	
12. The tool was helpful in facilitating discussions with other stakeholder.								Not used operationally	

ZDC 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.				X				Neutral only because it's not a regular tool. If it were on the stand-alone it would be different.	
2. I was adequately trained on the use of the tool.			X					Not much advanced notice. A couple of back-to-back days of training would be good. It's tough to train on the job.	
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		Very straightforward.
5. The timeline display color coding accurately portrayed forecasted weather impacts.						X			
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.						X			
7. It was easy to understand the notion of "permeability".							X	It's (the ATM problem) just so real-time. It is difficult for anyone or any tool to completely capture the permeability "picture," as it changes	

ZDC 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
								every minute with weather moving, gaps opening and closing, and military airspace going active/inactive.	
8. The breakdown of low/med/high impact was helpful.							X		
9. The low/med/high impact cutoffs were accurate.							X		
10. The presentation of forecast uncertainty was helpful.							X		
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.						X			
12. The tool was helpful in facilitating discussions with other stakeholder.								Out of sight, out of mind (Needs to be on the stand-alone.)	

ZDC 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.					X			"• Problems accessing it • Site down/slow • Password problems"	

ZDC 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
2. I was adequately trained on the use of the tool.			X					"• No time to train • Would like to train during impact"	
3. I would like to continue evaluating the tool.					X				
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.				X				User would like to see 15-30 minute intervals on the graph	
5. The timeline display color coding accurately portrayed forecasted weather impacts.					X				
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.				X				"• Too ""plain"". FSM provides similar data but is easier to read and less ""plain"". • Top to bottom is counter-intuitive"	
7. It was easy to understand the notion of "permeability".	X							Maybe constraints would be better than permeability	
8. The breakdown of low/med/high impact was helpful.					X			User feels putting high impact at the top and low impact at the bottom is more intuitive	

ZDC 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
9. The low/med/high impact cutoffs were accurate.					X			Maybe more medium than high	
10. The presentation of forecast uncertainty was helpful.						X			
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.						X			
12. The tool was helpful in facilitating discussions with other stakeholder.		X						"• Too many tools • Not everybody uses this"	

ATCSCC 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.						X			Convection does not stop at the end of October"-when MITLL shuts off CoSPA-"We need a tool like TFI just about year round"…thunderstorms continue to develop even during the winter across the south
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.							X	Would definitely like to keep evaluating the tool and would like to have more than 8hrs.	
Color-Coded Forecast Timeline									

ATCSCC 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
4. The color-coded timeline display was easy to use and understand.							X		I love the new slider bar on the timeline, but you (MITLL) can reduce the space of the color bars…I don't need that much real-estate to view red, yellow or green.
5. The timeline display color coding accurately portrayed forecasted weather impacts.						X			
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.					X				The model was not perfect…what model is?…but I found TFI to generally be accurate when I viewed it during severe weather outbreaks.
7. It was easy to understand the notion of "permeability".			X					I found the permeability scale a bit backwards at times…having to remember that say a 70% meant that I was losing 30% of my airspace.	
8. The breakdown of low/med/high impact was helpful.						X			

ATCSCC 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
9. The low/med/high impact cutoffs were accurate.						X		I thought that your low, medium and high classifications-in general-were fairly appropriate". "It's going to differ from airspace to airspace, but I thought your initial settings were good.	
10. The presentation of forecast uncertainty was helpful.			X						
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.							X		"• This tool has been the first of its kind that we've seen in here." "I'll need to work with it more, but I feel it's a step in the right direction; a big step!""
12. The tool was helpful in facilitating discussions with other stakeholder.				X				I'm not sure if the tool was helpful in facilitating discussions only because it did not seem to be widely used this summer." Only select centers and airlines seemed to know about it.	• We have a strategic webinar that command center facilitates on SWAP days to coordinate routes with the users. This tool would be a good product to have to get everyone on the same page."

ATCSCC 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X	I had no problem using and understanding the application…it's a great first start to a new tool like this.	It may not happen as often in December to February…but we always have a handful of days we wish we had CoSPA and now TFI.
2. I was adequately trained on the use of the tool.							X	Training was great, very intuitive.	
3. I would like to continue evaluating the tool.							X	I wish we could view it all year.	
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.						X			TFI was strategically accurate most of the summer when I had time to view it. I say strategically because there were days when the 8hr forecast was not so sharp in terms of storm placement, BUT, I could use TFI to identify potential trouble spots and use the tool to begin generating discussion on reroutes or AFPs.
5. The timeline display color coding accurately portrayed forecasted weather impacts.					X				
TFI Forecast Graph Questions									

ATCSCC 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
6. The TFI forecast graph was easy to use and understand.					X			The graph was a bit hard to understand at first.	I'm not sure if I want actual throughput rates, but knowing what the historical average of VFR rates per region, would be very useful. Also, please give us the traditional AFP regions.
7. It was easy to understand the notion of "permeability".			X					I'm still trying to get used to permeability.	
8. The breakdown of low/med/high impact was helpful.					X				
9. The low/med/high impact cutoffs were accurate.						X			
10. The presentation of forecast uncertainty was helpful.			X						
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.						X		The tool was useful internally to generate discussion when it came time to decide if AFPs or reroutes might be needed.	
12. The tool was helpful in facilitating discussions with other stakeholder.					X			I think the tool needs to be more widely used if we are going to generate that same discussion with the stakeholders.	

ATCSCC 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		
5. The timeline display color coding accurately portrayed forecasted weather impacts.					X			Not sure if the color timeline always indicated an accurate impact…that depended on the region and the actual forecast.	
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.					X			The graph was a bit confusing the first time I opened it…but it's now fairly self-explanatory to me.	• I would also like to see the rates you told us about in training…it would be good to see them plotted along with the % loss…I need to know a percent of what number I'm losing in capacity. • Please give us the standard AFPs…I like the FCAs you have for
7. It was easy to understand the notion of "permeability".			X					Permeability is ok, but we deal in loss of airspace and capacity…even throughput would be better than permeability.	

ATCSCC 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
8. The breakdown of low/med/high impact was helpful.				X					areas where AFPs don't exist, but I'd like to see our everyday AFPs as well.
9. The low/med/high impact cutoffs were accurate.						X			
10. The presentation of forecast uncertainty was helpful.		X						I didn't use the uncertainty much…not sure if I can relate to it in my decisions.	
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.						X			
12. The tool was helpful in facilitating discussions with other stakeholder.				X					

ATCSCC 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		I can see the use in keeping CoSPA on all year long…maybe not TFI, but definitely CoSPA…there are many days across the SW and SE in the
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.						X			

ATCSCC 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
									winter when convection continues to occur.
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.						X		I liked and understood the color coded impacts, but did not fully understand how to interpret your confidence…that blue shading.	
5. The timeline display color coding accurately portrayed forecasted weather impacts.						X			
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.						X			
7. It was easy to understand the notion of "permeability".							X	I understood permeability instantly, but you really want to plot a product that gets to the heart of strategic planning…capacity, demand, actual rates based on your historical examination of each FCA region.	
8. The breakdown of low/med/high impact was helpful.						X			
9. The low/med/high impact cutoffs						X		I think your high,	

ATCSCC 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
were accurate.								medium, low impact rating gets "it" in the ballpark to begin. That's all you need at 6 or 8hrs.	
10. The presentation of forecast uncertainty was helpful.				X					
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.							X		• I do approve of the smaller FCA regions you added, like in the ZNY area (ZNY01A/ZNY01B). First, you really need to plot more of the traditional AFPs like OB1, however, I think you are on the right track with the smaller regions. I would not only like to know about throughput around the OB1 region, but with your smaller FCAs I can begin to evaluate the arrival and departure corridors as we get closer to the event. I realize that uncertainty (in the
12. The tool was helpful in facilitating discussions with other stakeholder.				X					

ATCSCC 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
									convective forecast) grows with smaller regions, but I can accept that knowing that I don't have to worry about all of the demand. I can choose at 8hrs to let the west coast go, but make sure airlines fuel for potential reroutes. Also, I have the ability to reassess every hour up to the 3 and 4 hour mark and continue to grab demand from say ORD to reduce my flow through ZNY; we have options. • What you really need to do in order to gain support for this tool is document several examples from this past SWAP season and present them to us (ATCSCC) and the users (airlines). In order to facilitate those discussions (SPTs) and

ATCSCC 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
									to negotiate the sometimes needed lower rates, you need to get the customers on board as well. • I think that refined, your application (TFI) could provide the weather to ATC impact translation that would eventually feed one of our TFMS products that would allow us (ATCSCC) to then develop traffic demand lists and calculate the amount of reduction in demand.

ATCSCC 5	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		Convection doesn't just stop at the end of October (when CoSPA gets turned off). We
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating							X	Without a doubt, I	

ATCSCC 5	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
the tool.								would like to continue evaluating this tool!" I wish you could keep it on all year.	have to deal with the threat of storms through the winter months.
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		
5. The timeline display color coding accurately portrayed forecasted weather impacts.							X		
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.						X			• I wish you would work on this permeability naming. I want to see rates, actual rates. Maybe not just one number, but possibly a range. How about some kind of mouse-over feature? Where for each one of your plotted points on the graph you could mouse over the point and it would display a range of narrow band of potential rates. • I'm not sold on the uncertainty, but I do
7. It was easy to understand the notion of "permeability".					X				
8. The breakdown of low/med/high impact was helpful.							X		
9. The low/med/high impact cutoffs were accurate.						X			
10. The presentation of forecast uncertainty was helpful.									

ATCSCC 5	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
									feel, however, that there were many days, including SWAP days when you (MITLL) were present at our facility, that TFI provided accurate, strategic information that could potentially aid in development of several AFPs.
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.							X		I was continually reminding my co-workers (on SWAP days when MITLL was not present) that the tool was available for evaluation." "There was one convective event (I can't remember the date) where early forecasts (other than CoSPA/TFI) were indicating the need for AFPs and they were being planned for by our severe weather folks. I took a look at TFI and they barely
12. The tool was helpful in facilitating discussions with other stakeholder.						X			

ATCSCC 5	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
									showed yellow and mostly green, so they were indicating that AFPs might not be needed. I advised severe weather to hold off implementing those AFPs, and sure enough, the other forecasts we had been looking at eventually backed-off of the event. TFI had it right from the start!

ATCSCC 6	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.						X			
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.						X			
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.					X				I'm not sure I like the way the color-coded

ATCSCC 6	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
5. The timeline display color coding accurately portrayed forecasted weather impacts.						X			and scale ranges are set up. My mind thinks the scale of your permeability should be reversed; high impact up top with low impact down the bottom.
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.					X				
7. It was easy to understand the notion of "permeability".					X			Not crazy about permeability. Give me demand or capacity or just give me the rate your tool suggests.	
8. The breakdown of low/med/high impact was helpful.					X				
9. The low/med/high impact cutoffs were accurate.						X		I do think the color code scale is fairly close to the impact cut-offs." (i.e., low, medium, high impact)	
10. The presentation of forecast uncertainty was helpful.			X					I really didn't use the uncertainty much. I understand it and I understand what you are trying to show, but not sure it's displayed	

ATCSCC 6	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
								in the best way.	
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.						X			
12. The tool was helpful in facilitating discussions with other stakeholder.									

ZOB 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		TFI was used during a conversation with SCC to determine the level of impact. TFI suggested 60% of capacity (40% permeability). SCC agreed and set AFP throughput according to TFI guidance.
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		

ZOB 1	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
5. The timeline display color coding accurately portrayed forecasted weather impacts.						X		Better than RAPT.	
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.							X		
7. It was easy to understand the notion of "permeability".							X		
8. The breakdown of low/med/high impact was helpful.						X		Used % instead of color categories.	
9. The low/med/high impact cutoffs were accurate.						X			
10. The presentation of forecast uncertainty was helpful.							X		
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.							X		Need FCAs that more closely "build" existing AFPs; additional FCA segments.
12. The tool was helpful in facilitating discussions with other stakeholder.								See discussion under General Questions	

ZOB 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		
2. I was adequately trained on the use of the tool.							X	Did not use as much as would have had it been on the stand-alone display.	
3. I would like to continue evaluating the tool.							X		
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		
5. The timeline display color coding accurately portrayed forecasted weather impacts.							X		
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.			X						
7. It was easy to understand the notion of "permeability".							X		
8. The breakdown of low/med/high impact was helpful.				X				Did not use categories	
9. The low/med/high impact cutoffs were accurate.				X				Did not use categories	
10. The presentation of forecast uncertainty was helpful.				X				Did not use uncertainty	

ZOB 2	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.							X		Would be better on a stand-alone display
12. The tool was helpful in facilitating discussions with other stakeholder.									

ZOB 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.					X				
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.				X					
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		
5. The timeline display color coding accurately portrayed forecasted weather impacts.							X		
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.				X					

ZOB 3	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
7. It was easy to understand the notion of "permeability".				X					
8. The breakdown of low/med/high impact was helpful.							X		
9. The low/med/high impact cutoffs were accurate.				X					
10. The presentation of forecast uncertainty was helpful.							X		
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.					X				
12. The tool was helpful in facilitating discussions with other stakeholder.									

ZOB 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
General									
1. The tool was easy to use.							X		Trainers helped tremendously with the training and answering questions.
2. I was adequately trained on the use of the tool.							X		
3. I would like to continue evaluating the tool.							X		

ZOB 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
Color-Coded Forecast Timeline									
4. The color-coded timeline display was easy to use and understand.							X		Color code made sense and is similar to other products, such as insite (NOAA) and TDAs we produce in-house, that are impact-based.
5. The timeline display color coding accurately portrayed forecasted weather impacts.						X			
TFI Forecast Graph Questions									
6. The TFI forecast graph was easy to use and understand.						X			Overlaying jet routes, or having the option to toggle them on/off, would be helpful
7. It was easy to understand the notion of "permeability".				X					
8. The breakdown of low/med/high impact was helpful.						X			
9. The low/med/high impact cutoffs were accurate.				X					
10. The presentation of forecast uncertainty was helpful.							X		
Summary Questions									
11. The tool was helpful in understanding weather impacts on operations.				X					• Having the archive for verification will be nice; there are many days we cannot evaluate the impact convection has on air traffic during an event until several days later. • More in-house verification, as a team
12. The tool was helpful in facilitating discussions with other stakeholder.				X					

ZOB 4	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Comments Relative to Statements	General Comments
									effort between CWSU meteorologists and TMU, needs to be done to give value to impacts and accuracy of product for operational usage.

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LIST OF ACRONYMS

AFP	Airspace Flow Program
ARTCC	Air Route Traffic Control Center
ASDE-X	Airport Surface Detection Equipment, Model X
ASPM	Aviation Sytem Performance Metrics
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATM	Air Traffic Management
ATSC	Air Traffic System Controller
BOS	Boston International Airport
BWI	Baltimore Washington International Airport
CCFP	Collaborative Convective Forecast Product
CDR	Coded Departure Routes
CIWS	Corridor Integrated Weather System
CWSU	Center Weather Service Unit
DCA	Reagan National Airport
DWR	Dynamic Weather Routes
EDCT	Estimated Departure Clearance Time
ERP	Enhanced Reroute Planning
ET	Echo Tops
EWR	Newark International Airport
FAA	Federal Aviation Administration
FCA	Flow Constrained Areas
FSM	Flight Schedule Manager
GDP	Ground Delay Program
GSD	Global Systems Division
HRRR	High Resolution Rapid Refresh
IAD	Washington Dulles International Airport
ITWS	Integrated Terminal Weather System
JFK	John F. Kennedy International Airport
LAMP	Local Aviation Model Output Statistics Program
LGA	LaGuardia International Airport
METAR	Meteorological Terminal Aviation Routine Weather Report
MITLL	Massachusetts Institute of Technology Lincoln Laboratory
NAM	National Aviation Meteorologist
NAS	National Airspace System
NCAR	National Center for Atmospheric Research
NEXRAD	Next Generation Weather Radar

NOAA	National Oceanic and Atmospheric Administration
NOM	National Operations Manager
NY	New York
OEP	Operational Evolution Partnership
OPSNET	Operations Network
PHL	Philadelphia International Airport
RAPT	Route Availability Planning Tool
SA-AFP	Situational Awareness – Airspace Flow Program
SA-R	Situational Awareness - Route
SD	Situation Display
SPT	Strategic Planning Telecon
SREF	Short Range Ensemble Forecast
STMC	Supervisor Traffic Management Coordinator
SWAP	Severe Weather Avoidance Planning
TFI	Traffic Flow Impact
TMC	Traffic Management Coordinator
TMI	Traffic Management Initiative
TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control
UTC	Coordinated Universal Time
VIL	Vertically Integrated Liquid water
ZBW	Boston Air Route Traffic Control Center
ZDC	Washington DC Air Route Traffic Control Center
ZNY	New York Air Route Traffic Control Center
ZOB	Cleveland Air Route Traffic Control Center

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