4.1 USE OF OPERATIONALLY AVAILABLE WEATHER FORECAST PRODUCTS BEYOND 6 HOURS FOR AIR TRAFFIC STRATEGIC PLANNING

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1. INTRODUCTION

A shared understanding of future weather, its expected impact and how it will develop over time are critical to efficiently and effectively managing the United States National Airspace System (NAS). One of the significant issues faced by system managers and users is having a common language for the discussion of weather and its potential for impacting the system, and ultimately developing synchronized plans that effectively manage air traffic around or through the weather. The Federal Aviation Administration (FAA), The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) and the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Storm Prediction Center (SPC) have teamed to explore concepts that would apply standard definitions and levels of response required by the system users based on identified weather events. These definitions are collectively referred to as a *Traffic Flow Management (TFM) Weather Management Matrix (*Fig. 1). The matrix connects existing National Weather Service (NWS) terminology to aviation and traffic flow management using currently available convective forecast products. The products referenced are readily available to users, but may not be specifically targeted for aviation purposes.

Currently in the United States, FAA Traffic Managers and users of the NAS collaborate every two hours to review the system, identify potential impacts, and construct strategies for reducing the impact of weather on air traffic. This collaboration activity orchestrated by the Air Traffic Control System Command Center (ATCSCC or "Command Center") utilizes a combination of conference calls (or "telcons") and web applications to balance air traffic demand with available airspace capacity. This process becomes increasingly challenging on days with synoptic scale convective weather outbreaks that are typical during what is historically categorized as the "convective weather season," or March through October. During this period an online Collaborative Convective Forecast Product (CCFP) is developed by the NOAA/NWS/Aviation Weather Center (AWC) after collaboration with the Meteorological Service of Canada, NWS Center Weather Service Units, and meteorological offices of airlines and service providers, and then used as the common weather picture. Both FAA and NAS users access this web-based product to view areas of forecasted convective weather that meet specific criteria in the two-, four-, and six-hour time frames.

Beyond the six-hour time frame currently operational products including the SPC Day 1 and Day 2 Categorical and Probabilistic Outlooks, as well as specialized aviation weather guidance generated from the Short Range Ensemble Forecast (SREF) system, provide convective weather guidance and decision support. Guidance from this type of "Outlook" information can aid in the strategic decision making process for traffic flow management initiatives when used in conjunction with current CCFP forecast methods. The use of Outlook and Probabilistic forecast products in conjunction with the *TFM Weather Management Matrix* is proposed to augment the current CCFP process. The use of these products will allow traffic managers to recognize weather impacts earlier in the planning process and may give decision makers more time to develop improved mitigation plans and reduce overall system delays during synoptic scale convective weather events.

This document presents the proposed TFM Weather Management Matrix model, and by using data from 10 June 2008, illustrates how the matrix could be applied to incremental decision making. A case study then illustrates the operational benefit of providing system stakeholders with the proposed matrix to strategically understand and subsequently manage air traffic demand in the face of these large-scale convective outbreaks.

2. TFM WEATHER MANAGEMENT MATRIX

The NWS has a multi-tiered "Ready, Set, Go!" concept for alerting their customers and partners to hazardous weather. Their vernacular uses the terms

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"Outlook," "Watch," and "Warning," (or "Advisory" if warning thresholds are not met) products to alert for potentially significant weather. By fusing this methodology with traffic flow management concepts, we developed the TFM Weather Management Matrix model (Fig. 1) to create an initial link between the potential for major air traffic disruption due to convective weather and the NWS severe weather alerting system. The matrix enhances situational awareness among all stakeholders by promoting FAA strategic decision making in increments over time based on an established process. Building on each layer of the decision process, the Command Center collects information from predefined supplemental weather resources and shares the possibility of weather events through the current advisory process by issuing a new type of advisory called the Critical Event Statement (CES). The matrix model supplements traffic management strategic planning by referencing certain meteorological data issued by the weather community that collectively reveals aspects ("clues") of convective weather and aligns it with the appropriate phases of strategic planning.

Statement	Lead Time	Certainty of Event	Outcome
Outlook: Overnight review of weather forecast data to determine if TFM scenario modeling will be necessary for **strategic management**	At least **10-12hrs** in advance. Wx data updates at approximately 06z. This is a key time period to start establishing a TFM strategy for the coming day	High probability of convective impact based on overnight review of weather forecast. Reference data such as Jet Stream, Surface Analysis/Progs, SPC Day 1 Convective Outlook	TFM Programs possible: Provides for ATCSCC Traffic Management intentions to filter through ARTCC's and customers so all stakeholders can plan and deploy accordingly
Watch: Early morning SPT issues TFM Watch/Advisory to customers for probability of programs today **(Wx/Impact Translation)**	At least **8 hrs** prior if weather forecast continues to favor a convective outbreak based on Outlook statement	Risk of convective weather continues to be evident or has increased in likelihood based on probabilistic forecast data	Customers are notified on Planning Telcon to prepare for SWAP. AFP's and other TMIs are highly probable today. Plan of action is shared but not executed (no traffic moved).
Significant: TFM programs GS, GDP, AFP's are implemented. Traffic has option to reroute at this point	At least **6 hrs** prior based on CCFP 6hr forecast indicating convective weather within the same areas indicated by the "Watch" and "Outlook"	Forecast continues to show evidence of convective and/or imminent weather with a high probability of occurrence	Requires immediate action by customers to protect respective schedules. Implementation of programs by ATCSCC
Warning: Incorporate this into TFM impacts and or solution set. (**Tactical Planning begins**)	At least **4hrs** or less to show increasing confidence and or coverage.	Convective weather event has begun to occur with a high probability of intensification	Requires action to protect against large scale delays and handling of arrival and departure flows

Figure 1. TFM Weather Management Matrix

2.1. NAS Critical Event Statement (CES) Examples:

Outlook – Information beyond the twelve-hour forecast indicates the probability of convective weather. The Outlook Advisory states possible traffic management initiatives (TMI) and expected locations.

Watch – Risk of a convective weather event remains evident within the eight-hour time frame prior to forecasted timing of convective initiation. The *Watch Advisory* states which TMIs are highly probable with modeled flow rates and average delay numbers readily available for discussion during a subsequent planning telcon.

Significant – When the six-hour CCFP forecast is issued and warrants an actionable response by traffic managers at the command center, the plausibility of the CCFP is validated based on previously collected information from earlier SPC and CCFP forecasts, and the *Significant Advisory* is issued. This is the critical decision point for strategic planning and the cue to begin off loading volume from routes that are expected to become constrained by convective weather, TMIs are now executed.

Warning – Tactical planning (not tactical movement of traffic) should begin approximately four hours prior to the point at which convective initiation is expected to occur based on the latest forecast guidance. This is the final step of the matrix that leads into the tactical environment and subsequent tactical movement of traffic. The *Warning Advisory* states what actions, in addition to the current TMIs, can be expected to take place to mitigate convective weather impacts on the NAS. It is at this point in the decision-making process that planning of tactical strategies should commence in order to anticipate reroutes and deviations as convection develops.

2.2. MODEL METHODOLOGY

The intent of the matrix is to encourage proactive decision-making by all NAS stakeholders in anticipation of convective weather constraints, and build upon collected knowledge to incrementally raise system awareness of significant weather impact mitigation plans. By the time convective weather initiation occurs, there should be no surprises when flights are rerouted and delays are taken. With the matrix model in place, it is expected those reroutes will have been anticipated and that the system delay will be comparatively shorter than the current procedures allow with similar weather events. To best leverage the limited resources available on a daily basis, and to maximize the interpretive benefits of meteorological data into the traffic management environment, the matrix guides the FAA and users to focus only on those regions (or regions of interest) illustrated on the SPC Outlook. For example, a risk area of convective weather across the northeastern United States would suggest FAA review staffing levels for a particular duty shift in the New York ARTCC (ZNY) and surrounding centers. In addition, NAS users would have an opportunity to plan based on either operational impact to their hubs, their respective business models, and/or cost-loss tolerances. Even resources outside of the United States such as NavCanada and international carriers could benefit by the early exchange of information and subsequent actions pertaining to the operational impact of weather.

3. STRATEGIC PLANNING AND RISK MANAGEMENT

The Command Center conducts strategic planning for traffic management using conference calls and web based applications. Conference calls (telcons) occur every two hours (Fig. 2) and focus on planning operations in the NAS for the next six hours. As described earlier, the planning telcons include both FAA traffic management and NAS users who collaboratively assemble a plan of operations based on demand, the current weather, and weather forecasts from the CCFP and Terminal Aerodrome Forecasts (TAF). The current strategic plan for traffic management is then documented in the Operations Plan and published on the ATCSCC website as an Advisory viewable by all stakeholders.

Operational use of additional forecast products has the potential to extend systemic situational awareness beyond the six-hour CCFP forecast period. Traffic managers can hedge against the risk of high impact convective weather forecasted earlier in the day by referencing predefined supplemental weather information (longer-range forecasts) earlier in the planning process. High stake decisions to reduce flow rates, implement alternate routing structures, or offload traffic onto alternate routes too far in advance of convective initiation bring extremely high risk. TMIs issued prematurely can propagate unnecessary delays throughout the NAS due to the sensitivity of balancing demand with capacity. Use of the model can provide traffic managers with a level of certainty that instills confidence in their decision-making and their own subjective probability of forecasted weather to impact the NAS. The final decision to execute TMIs based on the increasing risk of a convective weather outbreak have a better chance of being effective when strategic decisions can be made incrementally over time.

4. CCFP CONCEPT

Operational use of the CCFP began in 2000. It provides a graphical representation of expected convective occurrences at two, four, and six hours after the issuance time. It is intended to be used for strategic air traffic management planning during the en route phase of flight and is designed to aid in the reduction of air traffic delays, reroutes, and cancellations influenced by significant convective events. It is not intended to be used for traffic flow control in the airport terminal environment, nor for tactical decisions.

The CCFP addresses two major needs by providing:

- An accurate representation of significant convection for strategic air traffic flow management decision making
- A common forecast baseline established through collaboration

The primary users of the final collaborated CCFP are air traffic managers from the FAA and air traffic coordinators, dispatchers, and pilots from the user community. What makes the CCFP concept unique is the collaboration among stakeholders to establish a baseline forecast to promote common situational awareness. The constantly evolving operational plan is reviewed and agreed upon every two hours immediately following the issuance of the updated CCFP. Because the CCFP only provides strategic guidance for managing traffic in the NAS out to six hours, there is little discussion on the collaborative telcons of forecasts beyond that time frame. It is noteworthy to add that both FAA and users may be referencing other forecasting tools, but those tools are not used for collaborative decision-making.

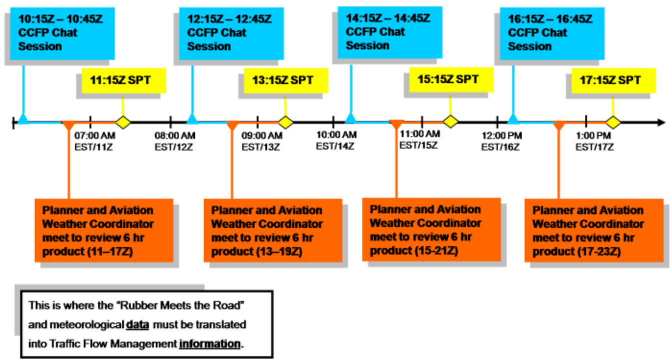

Figure 2. CCFP Development Process Timeline

4.1. CCFP CRITERIA

In accordance with the AWC (http://aviationweather.gov/products/ccfp/docs/pdd-ccfp.pdf, 2008), convection, for the purposes of the CCFP forecast, is defined as a polygon of at least 3000 square miles that contains minimum criteria of:

- 25% coverage with radar echoes of at least 40 dBZ composite reflectivity, and
- A coverage of at least 25% with echo tops of FL250 or greater, and
- A confidence of at least 25%

All three of these threshold criteria are required to be included in a CCFP forecast. Given the defined specific criteria, CCFP forecasts are necessarily emphasizing larger-scale convective outbreaks. In traffic management, the location of convective weather can, at times, be more crucial than the severity. Smaller convective weather events that do not meet CCFP criteria but impact highly congested airspace can have significant impact on system efficiency. These types of convective weather events are not addressed through the CCFP process, which can diminish strategic planning and situational awareness. Adding supplemental forecast data (such as SPC products) to provide longer-range information to the criteria requirements of the CCFP could offer timely planning improvements.

5. SPC PRODUCT DESCRIPTIONS

One of the primary responsibilities of the SPC is the prediction of severe convective weather across the United States on time scales ranging from a few hours to eight days. To meet these responsibilities, the SPC issues tornado and severe thunderstorm watches, mesoscale discussions, and convective outlooks for the Day 1 through 8 time frame. The convective outlooks contain graphics of general thunderstorm areas, categorical risks of severe thunderstorms and associated severe probabilities. These outlooks highlight regions where thunderstorms and severe thunderstorms are expected, and include both categorical and probabilistic information. The NWS considers a thunderstorm as severe if a storm produces: hail of three-quarters of an inch or greater, winds of 50 knots or greater, and/or tornados.

The initial Day 1 Outlook is released at 0600 UTC and is valid for the 24-hour period from 1200 UTC through 1200 UTC and is subsequently updated four times during the day. Operational forecast products issued by the SPC also embrace the concepts of uncertainty and decision support. Nearly all operational products include an accompanying representation of the uncertainty, generally in the form of a probabilistic forecast supplementing the categorical (or deterministic) information (Bright et al. 2008).

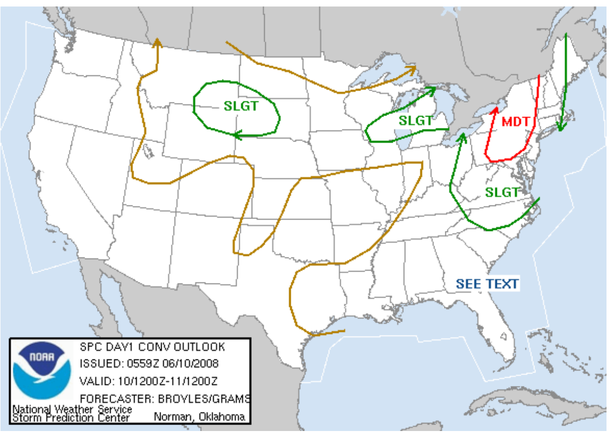

Figure 3. SPC Day 1 Categorical Outlook: Issued 0600 UTC, Valid 1200 UTC 10 Jun - 1200 UTC 11 Jun

As depicted in (Fig. 3), the following are SPC's definitions of "SLGT" and "MDT" risks[*]:

- "SLGT" - Slight risk, both graphic and text. A SLGT risk implies well-organized severe thunderstorms are expected but in small numbers and/or low coverage
- MDT - Moderate risk, both graphic and text. MDT risks imply a greater concentration of severe thunderstorms, and in most situations, greater magnitude of severe weather.

The remainder of this paper will focus primarily on the utility of the Day 1 convective outlook in TFM decision support beyond the CCFP valid period (i.e., in roughly the 6- to 24-hour time period)[*].

From a TFM perspective, the SPC Day 1 Outlook forecast can serve as an early indicator, or "big picture," of where convective activity may impact aviation later in the day. Each categorical forecast has an accompanying technical textual discussion written primarily for meteorologists or those familiar with meteorology. Typically, the discussion contains the building blocks to form enhanced TFM situational awareness, such as the general location, timing (e.g., early afternoon, late afternoon, early evening, etc.), and mode (e.g., linear convection, clusters or discrete cells) of expected convection over the United States. However, one has to read and translate the discussion from meteorological dictation to potential TFM impacts. For aviation experts already familiar with reading METARs (Aviation Routine Weather Reports), TAFs, and other aviation-related meteorological information, the text portion of the SPC Day 1 Outlook provides additional information on convective trends to validate and corroborate the six-hour CCFP forecast. With more confidence in interpreting the six hour CCFP, strategic decisions can be made in a more timely manner, thereby reducing the need to "wait and see" what the next iteration of the CCFP forecast brings.

The SPC forecasts are currently available at the Command Center via the Weather and Radar Processor (WARP) system, the FAA intranet, and the public web.

6. CASE STUDY (10 June 2008)

To illustrate how the TFM Weather Management Matrix model could be effective, an example case study using data from 10 June 2008 is provided. This particular convective event affected most of New England and New York southward to the western Carolinas from late morning into the mid-evening hours. Considerable reports of severe weather occurred across the region including nearly 60 reports of damaging wind gusts and large hail events in New York, Pennsylvania, Maryland, New Jersey and Virginia from 1800-0300 UTC.

In the past, Airspace Flow Programs (AFP)[*] advisories have usually been distributed in the late morning hours between 1500 UTC and 1700 UTC after the second or third CCFP issuance (Duquette, Huhn, 2007). On this particular day, AFPs were discussed on the first planning telcon at 1115 UTC. Advisory distribution occurred later, around the 1315 UTC

[*] NOAA's National Weather Service Storm Prediction Center website: http://www.spc.noaa.gov/misc/about.html#Convective%20Outlooks

[*] See http://www.spc.noaa.gov/ for more information on SPC products

[*]An AFP is "a traffic management (TM) process administered by the ATCSCC. Aircraft are assigned specific airspace arrival slots utilizing flight schedule monitor (FSM) to manage capacity and demand for a specific area of the National Airspace System (NAS). AFPs support the TM mission and mitigate the effects of en route constraints." - *http://cdm.fly.faa.gov*

planning Telcon based on the fact that a severe convective weather outbreak was forecast to occur during the afternoon hours in the northeast United States. Notice the time of implementation was earlier than historical data depicted. This was because additional weather resources were used to validate the CCFP, such as the SPC categorical and probabilistic outlooks.

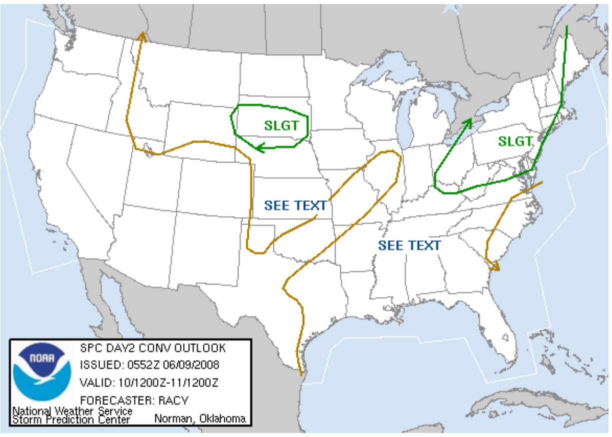

Figure 4. SPC Day 2 Categorical Convective Outlook: Issued 0552 UTC 9 Jun, valid 1200 UTC 10 Jun to 1200 UTC 11 Jun.

The SPC had forecasted a severe weather event across the northeastern United States as early as the Day 2 Outlook issued 0600 UTC 9 June (Fig. 4) and the Day 2 probability outlook (Fig. 5) issued at the same time. By the time the 0600 UTC SPC Day 1 Outlook was disseminated on 10 June, there was a fairly strong indication that severe convective weather would be impacting the northeastern states and a categorical moderate risk was issued (Fig. 3). Had the FAA used the TFM Weather Management Matrix model, the Command Center would have issued the *OUTLOOK CES* at this time indicating weather forecasts were depicting a strong chance of convective activity in the northeast for the afternoon of 10 June 2008.

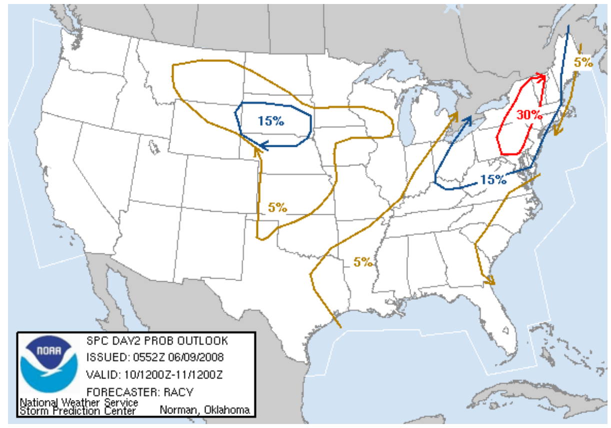

Figure 5. SPC Day 2 Probability Outlook: Issued 0552 UTC 9 Jun, valid 12 UTC 10 Jun to 12 UTC 11 Jun.

6.1. *1000 UTC 10 JUNE 2008 CCFP CHAT*

The CCFP chat session intended for the 1100 UTC product issuance began at 1000 UTC. Traffic managers received their first look into the afternoon hours as the six-hour CCFP forecasted convection out to 1700 UTC. A new feature that was added to the CCFP in 2008 was the addition of an Outlook statement (Fig. 6)**.** This proved very helpful in the early morning strategic planning. The additional text, available only in the CCFP development chat application, provided further guidance for traffic managers regarding the future trend of the forecast beyond the six-hour criteria limitation. In the case of 10 June 2008, the CCFP chat Outlook statement contained evidence that a convective outbreak would most likely impact late afternoon and early evening operations, corroborating what was highlighted by the SPC categorical outlooks earlier in the day.

> **AWC-Forecaster** ***10:11:02Z***
> **OUTLOOK 19Z thru 00Z is for ts to increase from wrn and cntrl NY swd thru cntrl PA and WV by 19Z, possibly as far south as wrn NC and as far east as MD. Ts will probably reach wrn New England and ern ptns of NY and PA after 21Z. At this time it appears highest concentration / coverage of ts from 21Z thru 00Z is most likely to be fm VT thru cntrl and ern ptns of NY and PA and possibly as far south as MD and nrn VA.**

Figure 6. CCFP Chat Session Excerpt

6.2. *10 June 2008 Events*

The CCFP forecast issued at 1100 UTC provided guidance for the next six hours through 1700 UTC (Fig. 7). A CCFP forecast of sparse coverage over western New York and Pennsylvania was not necessarily an actionable item by traffic managers. Note it does not include reference to the Outlook statement issued in the chat session. However, because that information was passed to the national planner by the Command Center weather coordinator who monitored the chat session, it provided guidance on the trending of the weather forecast over the next eight to twelve hours.

By combining information gleaned from the 06 UTC SPC Day 1 categorical outlook, the 1000 - 1100 UTC CCFP chat outlook, and the new 1100 UTC graphical CCFP, traffic managers moved proactively forward modeling AFP flow rates. In addition, the Command Center initiated contact with NavCanada. Together, they coordinated Canadian airspace use for offloading traffic volume. This decision was made in lieu of waiting an additional two hours for the next CCFP (1300 UTC) to validate operational impact and justify a traffic management decision. However, this information was not yet shared with NAS stakeholders, and an issuance of the CES would have been an improvement to the overall planning process.

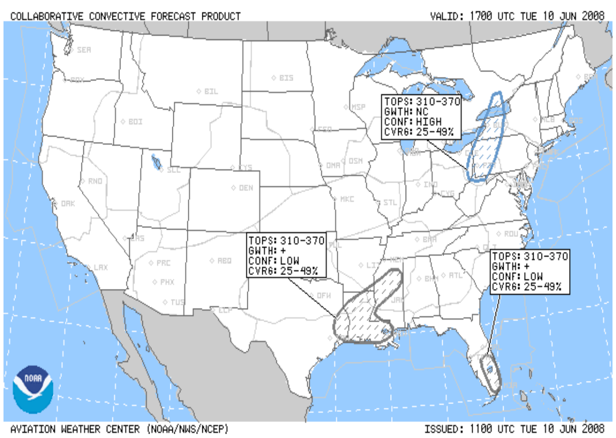

Figure 7. CCFP Six-Hour Forecast: Issued 1100 UTC, Valid at 1700 UTC 10 Jun

Within the TFM Weather Management Matrix, based on subsequent upgrades and consistency in the forecast, this is the point at which the second layer of information, the *WATCH CES,* would be released to all stakeholders up to eight hours from forecasted initiation to indicate which traffic management initiatives would be probable.

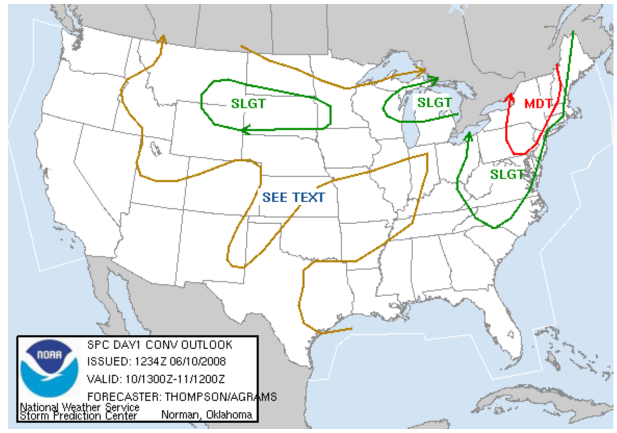

Figure 8. SPC Day 1 Categorical Outlook. Issued 1234 UTC, valid 1300 UTC to 1200 UTC 11 Jun

The SPC subsequently updated the Day 1 categorical outlook (Fig. 8) and enhanced thunderstorm probability outlook (Fig. 9) just prior to 1300 UTC, maintaining the moderate risk for severe thunderstorms and a high probability for thunderstorms in general. The "enhanced resolution thunder probabilities" take into account both the expected areal coverage and probability for thunder to occur. Therefore, a 40% probability means that given similar environmental conditions, thunder would be observed at any one location (in either a county or city) within the 40% thunder probability area four times out of ten, or 40% of the time."

–(h*ttp://www.spc.noaa.gov/products/exper/enhtstm/)*
This forecast covered a 14-hour period.[*]

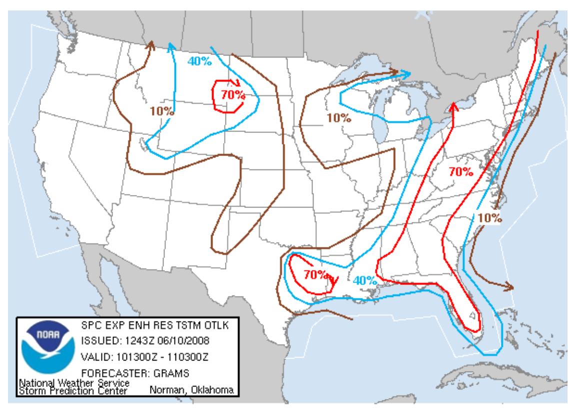

Figure 9. SPC Enhanced Thunderstorm Probability Outlook: Issued 1243 UTC, valid 1300 UTC 10 Jun to 1200 UTC 11 Jun

[*] Note that in spring 2009 this forecast will update at 1300 UTC with a valid time of 1600-2000 UTC, providing an additional degree of confidence across a shorter time period. In 2009, all of the Enhanced Thunderstorm Probability forecasts will update 5 times daily on the same schedule as the Day 1 Categorical Outlook: 06, 13, 1630, 20, and 01 UTC with valid times to coincide with the peak air traffic hours of late afternoon and early evening.

With the issuance of the six-hour CCFP at 1300 UTC (Fig. 10), it was evident to traffic managers that there would be significant capacity constraints later in the afternoon into and out of the Northeast. Because the command center modeled AFP flow rates based on the 1100 UTC CCFP (Fig.7) forecast and Outlook information in the chat session (Fig. 6), the details including the AFP start time and average delays were all readily available to be discussed on this planning Telcon with the customers and other stakeholders. Subsequently, AFPs were implemented with a start time of 1700 UTC. In accordance with the proposed TFM Weather Management Matrix, traffic managers had enough information to initiate preplanned initiatives and would now publish the *SIGNIFICANT CES* had the model been in place.

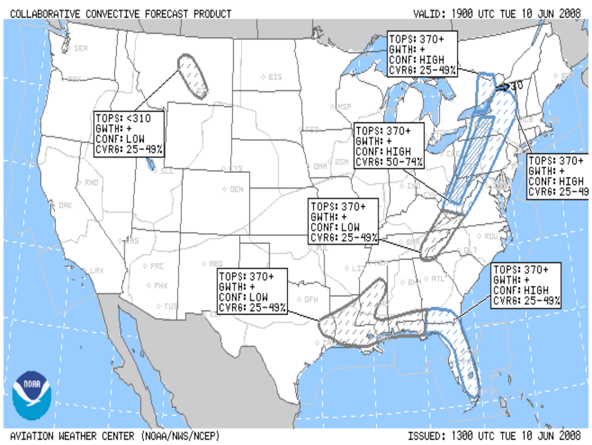

Figure 10. CCFP Six Hour Forecast: Issued 1300 UTC, valid at 1900 UTC 10 Jun

Event significance was further confirmed at 1405 UTC when the SPC issued a Tornado Watch (not shown) for a large portion of the Northeast. This type of alert indicated conditions were favorable for tornadoes and severe thunderstorms in and around the watch box area. The watch was valid from 1405 UTC thru 2200 UTC and alerted all NAS stakeholders to the possibilities of hail to 2.5 inches at the surface and aloft, wind gusts to 60 knots, and extreme turbulence and thunderstorm tops to FL500 (flight level 50,000 feet above mean sea level). This graphical watch box was displayed on the overhead screens in the command center. Although this meteorological data was not exclusively designed for aviation purposes, it represents a hazard to the safety of aviation. Considering this information within the strategic planning process was an example of gathering data incrementally and applying pertinent weather information over and above procedurally required products.

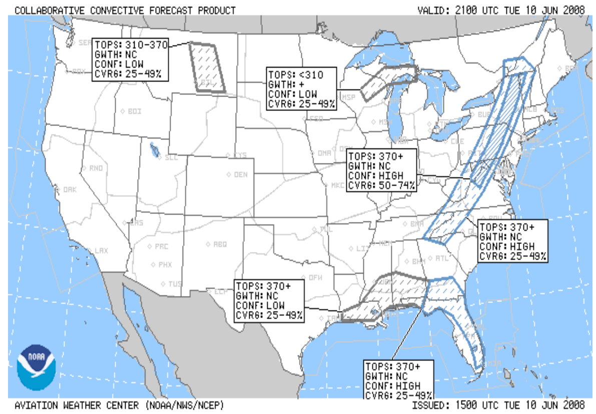

Figure 11. CCFP Six Hour Forecast: Issued 1500 UTC, valid at 2100 UTC 10 Jun

By the time the 1500 UTC CCFP had been published (Fig. 11), most stakeholders were aware of the potential capacity constraints and had made their respective strategic decisions to manage impacts to their own operations. Based on the 1500 UTC CCFP and the strategic planning that had transpired, collaboration on the 1515 UTC planning Telcon was minimal.

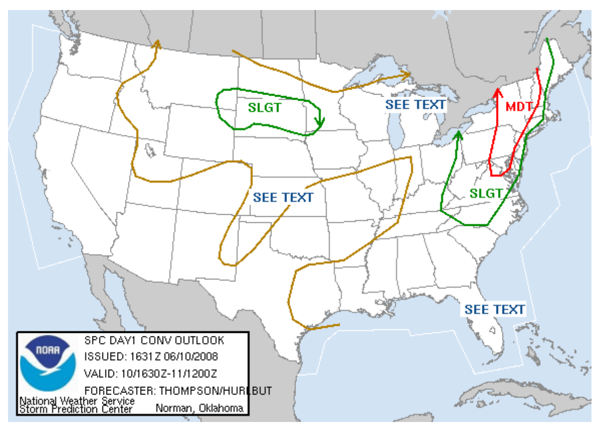

Figure 12. SPC Day 1 Categorical Outlook: Issued 1630 UTC, valid 1630 UTC 10 Jun to 1200 UTC 11 Jun

Given that the updated 1630 UTC SPC (Fig. 12) and 1700 UTC issuance of the CCFP (Fig. 13) offered little additional insight over morning telcons, no significant changes were made to traffic management initiatives established earlier that morning. The planning telcon at 1715 UTC was short with minimal discussion as the strategic plan continued to execute smoothly.

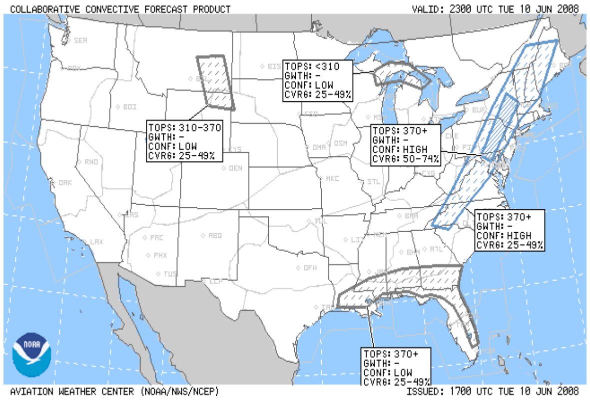

Figure 13. CCFP Six Hour Forecast: Issued 1700 UTC, valid at 2300 UTC 10 Jun

As indicated by the Operational Information System (OIS) National Airspace System Status page (Fig. 14), by 1715 UTC, AFP's were in place and the system was prepared for the expected weather.

NATIONAL AIRSPACE SYSTEM STATUS

(Note: This page will refresh every 5 minutes. Last updated Tue, 10 Jun 2008 17:19:09 UTC. Provided by the FAA's Air Traffic Control System Command Center.)

NATIONAL PROGRAMS

CONTROL ELEMENT	START	END	SCOPE	REASON	AVG	AAR	PR	ADVZY	DA
FCAA05	1700	0159	See Control Element...	WEATHER / TSTMS	60	--	70	052	DA
FCAA08	1700	0159	See Control Element...	WEATHER / TSTMS	31	--	115	053	DA

GROUND STOPS

ARPT	UPDATE	POE	SCOPE	REASON	ADVZY
IAH	1800	MED	1STTIER	WEATHER / THUNDERSTORMS	064

DELAY INFO

ARPT	AD	DD	TIME	REASON
IAH		+60	1712	TM Initiatives:MIT/MINIT:WX:TSTMS

AIRPORT CLOSURES

ARPT	TIME	REASON	REOPEN

DEICING

ARPT	DATE/TIME

Runway/Equipment Info

This is not a complete list of Runway/Equipment Status. Please consult the current NOTAMs for complete information.

Facility	Description

MISCELLANEOUS

NEXT OPS PLANNING TELCON: 1715Z

Figure 14. OIS National Airspace System Status: Issued 1719 UTC 10 Jun

By mid-afternoon, very warm boundary layer temperatures in the 80 – 90 degree Fahrenheit range coupled with the pre-existing moisture boosted mixed-layer Convective Available Potential Energy (MLCAPE) to 2875 J/Kg-1 amidst weak convective inhibition as evidenced by a special sounding released from Albany, NY (not shown). Given the approach of an upper level trough and associated large-scale ascent, the stage was set for widespread afternoon thunderstorm development. Just before 1900 UTC, visible satellite imagery and surface observations were indicative of cumulus cloud development and banding across eastern Pennsylvania, indicating convective initiation beginning to occur*.

With clues signifying convective initiation would soon occur, the transition to tactical operations had begun. In keeping with the methodology of the TFM Weather Management Matrix, it would be prudent at this time to publish the WARNING CES, the final layer of information collection and distribution within the model marking the end of strategic planning and the start of tactical planning. The steps of the model had built layer upon layer of various levels of weather information, each adding validation and support to the next forecast. By the time the WARNING CES is issued, by definition, there is a high probability of intense convective weather that requires action to protect against large-scale delays and efficient management of arrivals and departures.

Unfortunately, without a defined process such as the proposed TFM Weather Management Matrix and its consecutive Critical Event Statements, the need to move flows and slow traffic was not clearly understood by 1900 UTC. As storm cells exploded into forecasted convective weather areas, last minute reroutes were required as flights came upon impenetrable pockets of thunderstorms. The mixed convective mode coupled with widespread convective coverage during the daily peak of afternoon and evening air traffic demand put a high-degree of stress on the NAS.

AFP's were not adjusted with low enough rates early enough to meet the high constraints associated with the convective weather intensity and location. Numerous tactical initiatives were implemented to stop traffic into many of the northeast airports. Routes remained closed for departures out of the northeast (see the OIS Status Board in Figure 15), with numerous ground stops for en route weather and departure delays shows the need to apply tactical initiatives to what could have been a strategic problem.

NATIONAL AIRSPACE SYSTEM STATUS

(Note: This page will refresh every 5 minutes. Last updated Tue, 10 Jun 2008 22:14:30 UTC. Provided by the FAA's Air Traffic Control System Command Center.)

NATIONAL PROGRAMS

CONTROL ELEMENT	START	END	SCOPE	REASON	AVG	AAR	PR	ADVZY	DA
FCAA05	1700	0159	See Control Element...	WEATHER / THUNDERSTORMS	69	--	65	095	DA
FCAA08	1700	0259	See Control Element...	WEATHER / THUNDERSTORMS	65	--	95	092	DA

GROUND STOPS

ARPT	UPDATE	POE	SCOPE	REASON	ADVZY
BWI	2230	MED	ZDC ZID ZOB ZNY ZBW ZAU ZJX CZY	WEATHER / THUNDERSTORMS	112
DCA	2230	MED	ZDC ZID ZOB ZBW ZNY ZJX ZAU CZY	WEATHER / THUNDERSTORMS	113
EWR	2300	MED	ZAU ZMP ZID ZOB ZKC CZY	WEATHER / THUNDERSTORMS	121
IAD	2230	MED	ZDC ZID ZOB ZNY ZBW ZUA ZJX CZY	WEATHER / THUNDERSTORMS	114
JFK	2259	MED	ZAU ZMP ZKC ZID ZOB CZY	WEATHER / THUNDERSTORMS	118
LGA	2300	MED	NOWEST+CZY_AP	WEATHER / THUNDERSTORMS	120
MCO	2215	MED	ZJX ZTL ZDC ZHU	WEATHER / THUNDERSTORMS	111
PHL	2259	MED	ZAU ZMP ZKC ZID ZOB CZY	WEATHER / THUNDERSTORMS	117

DELAY INFO

ARPT	AD	DD	TIME	REASON
BWI		+105	2220	WX:TSTMS
DCA		+45	2200	WX:TSTMS
EWR		+75	2150	WX: SWAP
IAD		+90	2150	WX:TSTMS
LGA		+105	2153	TM Initiatives:MIT/MINIT:WX:Swap
MCO		+15	1902	WX:TSTMS
PDX		+30	1740	WX:LOW CEILING/VISIBILITY
PHL		-45	2202	TM Initiatives:GS:WX:Swap
SFO		+15	2013	WX:WIND
TEB		+60	2150	WX:TSTMS

AIRPORT CLOSURES

ARPT	TIME	REASON	REOPEN

Figure 15. OIS National Airspace System Status: Issued 2214 UTC 10 Jun

A major issue for NAS planners was the location of the convection that occurred within one of the most complex and congested airspaces in the world.

* Although satellite imagery is not currently considered an exclusive reason to move traffic, on clear days with forecasted severe weather it is an excellent indicator of thunderstorm initiation. Satellite imagery provides traffic managers with additional pertinent information to maintain situational awareness.

Additionally, the use of the matrix model would have preserved some of the situational history, which may lose continuity at times when a shift change and convective outbreak are unfolding simultaneously.

The CCFP outlook statement from 1011 UTC (Fig. 6) predicted thunderstorms to reach western New England and eastern portions of New York and Pennsylvania after 2100 UTC. Geographically, this airspace region is particularly prone to air traffic delays when convective weather develops. In fact, even widely spaced thunderstorms can have a significant impact on air traffic. At this time of high volume in the afternoon, traffic management initiatives would be required to mitigate weather impacts. As depicted in (Fig. 16), by 2305 UTC a snapshot of the WSR-88D infers multiple route blockages in and out of the New York metropolitan airports.

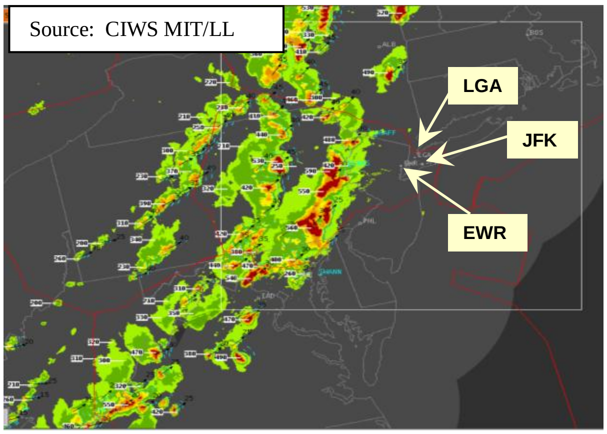

Figure 16. Observed Weather 2305 UTC

6.3. *Case Study Summary*

On 10 June 2008, convective weather was accurately forecasted to develop in a vulnerable area of the NAS. While current TFM strategic planning procedures do not include standardized product resources beyond the 6-hour CCFP, sufficient weather information was available in longer-range forecast products and was, to some extent, incorporated during the early hours of 10 June 2008. These forecasts verified quite well, as shown in (Fig. 17), which is a summary of severe weather reports (tornadoes, high winds, and large hail) received by the SPC. These types of weather phenomenon historically bring hazards to aviation and cause deviations and delays. The occurrence of such storms in the busiest corridor of the NAS placed a significant challenge on traffic managers. The overlay on (Fig 17) is the SPC 0600 UTC Day 1 Categorical Outlook for comparison. Not only was a "SLGT" risk classification given for the northeast, including Washington (ZDC) and Cleveland (ZOB) ARTCCs, but the NY metropolitan airports were included in a "MDT" risk.

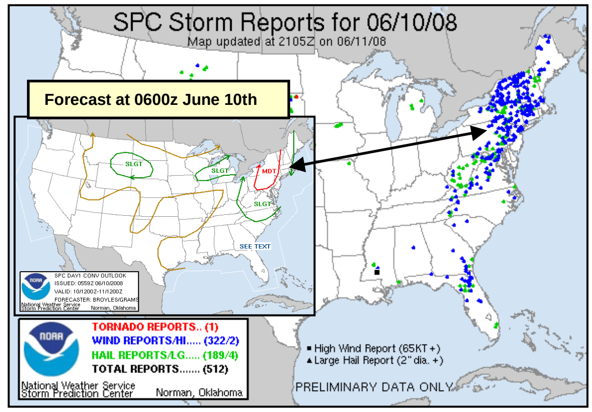

Figure 17. Storm Reports for 10 June 2008

Although SPC forecast product criteria are for the development of severe thunderstorms and are not directly oriented toward aviation, CAASD analysts conducted several case studies in 2008 and believe the validation of these particular SPC products to be sound enough for use in air traffic management strategic planning beyond 6 hours.

7. Potential Operational Use and Application of the TFM Weather Management Matrix

The operational use of the TFM Weather Management Matrix can provide advanced information regarding the potential for significant constraints on the NAS due to convective weather regardless of time. It is a process to promote common situational awareness among various stakeholders making it an event driven process and a likely precursor to large-scale traffic initiatives such as AFPs. For example, the Outlook could be issued as late as the first or second planning telcon for an evening constraint rather than during the overnight hours for an afternoon constraint. Also, it is presumed that using the matrix in conjunction with AFPs would give stakeholders who will be impacted the opportunity to strategize in a timely manner based on their various requirements and business models.

Since the percentage of CCFP high confidence/sparse coverage and high confidence/medium coverage increases as the afternoon progresses, using additional sources of weather information like the SPC forecasts helps to substantiate and anticipate the change from sparse coverage to medium coverage when it occurs.

The matrix integrates this information and provides a structure for including additional convective weather forecast information beyond the scope of the CCFP into the strategic planning process. The matrix still allows for the face-to-face exchange of weather data from the weather coordination position to the planner on days when a large-scale convective outbreak is forecast. "There is nearly universal agreement on a preference for face-to face weather briefings, even though the actual value remains intangible and uncertain" (Rodenhuis, 2006).

One last aspect of the TFM Weather Management Matrix is oversight. When an Outlook NAS Critical Event statement is released, a severe weather event coordinator position could be activated on the floor of the Command Center. This could be someone who is removed from routine tasks to keep a high level of situational awareness among traffic managers, smoothes the transition between shifts, and keeps stakeholders engaged in understanding the “big picture” for the day.

8. SUMMARY

Strategic planning is most effective when implemented as soon as information impacting the operation is known; therefore, on a daily basis the accuracy of weather forecasts at the six- to eight-hour time frame is most critical in developing the appropriate routing structure for the NAS. Through the use of a TFM Weather Management Matrix, it is possible to translate non-aviation specific weather data into useful TFM weather impact (decision support) information. This reduces the need to solely rely on a CCFP that does not provide sufficient “look ahead” information based on today’s operations and number of long haul flights operating in the NAS.

For aviation purposes beyond six hours, the SPC Day 1 Categorical Outlook answers the question, “Where is the region of interest for operational impact in the NAS today”? It can answer that question with a certain level of fidelity that can warrant the issuance of the NAS Critical Event Statement as the precursor to a broad based TMI like AFP’s.

By integrating the SPC forecast information into current phases of strategic planning, stakeholders are in a better position to make more informed decisions earlier, having time to model options and plan a level of efficiency that best meets the needs of their respective organizations rather than waiting to tactically react and be afforded minimal options.

With the use of the TFM Weather Management Matrix it is believed that strategic planning challenges can be better managed through improved situational awareness and incremental decision making. Future plans call for looking into additional examples and developing an operational process for implementing the matrix.

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