



CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT (CAASD)

Translating Forecast Data for Traffic Flow Management

NWS Aviation Weather Center

Aviation Weather Forum

April 14-16, 2009

The MITRE Corporation's Center for Advanced
Aviation Systems Development (CAASD):

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Summary

- **In order to facilitate better risk mitigation strategies for weather events, an incremental decision matrix begins a process of translating meteorological data into pertinent Traffic Flow Management (TFM) information**
 - **Establishes initial correlation of weather and TFM advisory messages**
 - **Enables closer synchronization of traffic management decision making (in the 6 hour out timeframe) and user decision making (in excess of 8 hours in some cases)**
 - **Provides guidance to normalize traffic management responses to weather-driven triggers**
 - **Implements a repeatable process to managing weather impact risks over time (e.g., throughout an entire weather event)**
 - **Defines event status statements for all stakeholders from a common platform**



Purpose

- **Extend Strategic Planning beyond the scope of the 6 hour Ops Plan in the near term**
- **Reduce the number of “Wait and See” delayed response issues by applying standard definitions and levels of response necessary to identified disruptive weather events.**
- **Take a preliminary step towards utilizing weather information for translation into operational impact**
- **Promote common situational awareness among various stakeholders by establishing an event driven process and likely precursor to large-scale traffic initiatives such as AFPs.**



What does this process accomplish?

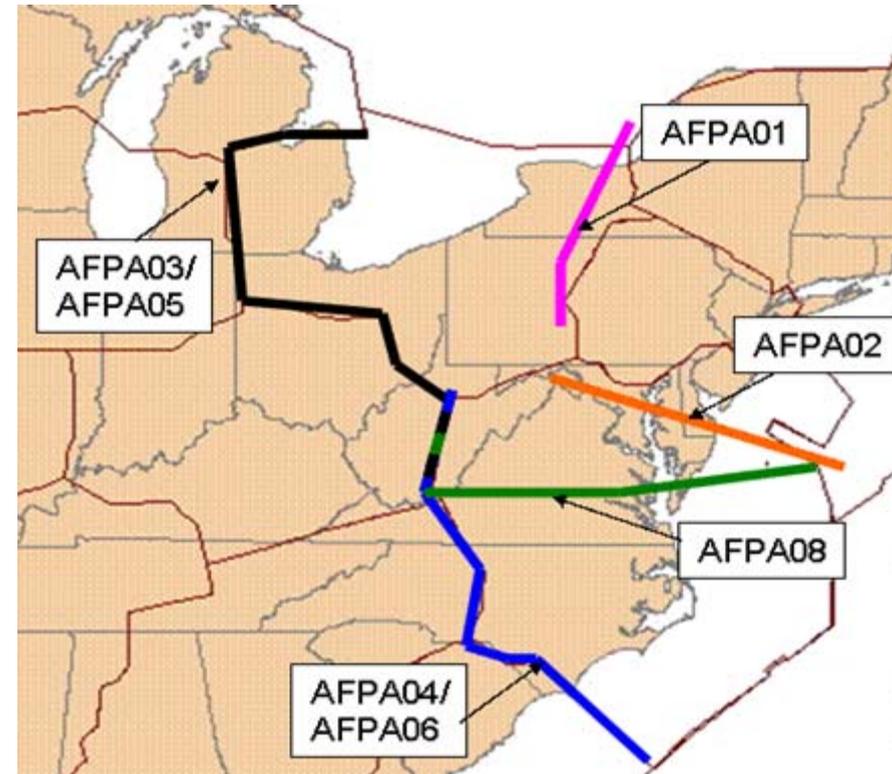
- **Convective weather historically has a high disruption factor for aviation. Therefore, even with advancements in forecast accuracy there is no net benefit to stakeholders if there is insufficient time for strategic planning.**
- **Using the matrix would give stakeholders the opportunity to strategize in a timely manner based on their level of risk associated with the Critical Event Statement (CES) advisories.**
 - **increases the opportunity for planning based on respective stakeholder business models, and/or cost-loss tolerances.**
 - **Provides structure to synchronize plans that effectively manage air traffic and optimize rerouting**
- **Disseminates information that stakeholders can use in their decision-making to mitigate: risk, NAS disruption, and costs prior to the Ops Plan timeframe.**
- **This matrix process can begin to quantify delays based on which customers reacted to the Critical Event Statement advisories and proactively rerouted themselves compared to those who did not.**



Operations Plan (OP)

- OP documents the daily plan for managing the National Airspace System
- Issued every 2 hours and covers a 6 hour period
 - First OP TELCON occurs at 7:15AM EST, thru 9:15 PM EST
 - Includes information about
 - Terminal and En Route constraints
 - Military operations affecting routes or airspace
 - Reroutes
 - Traffic Management Initiatives (TMIs) to include Ground Delay Programs (GDP), Ground Stops (GS) and Airspace Flow Programs (AFP)

• **AFP – Delays traffic at the departure airport that is planned to traverse a capacity constrained airspace**



• **GDP and GS – Delays traffic at the departure airport to manage demand at a capacity constrained destination**



Bridging the Weather-TFM Translation Gap Through Event-Driven Products

- The Storm Prediction Center (a national guidance center of the National Weather Service) issues watches for areas likely to produce tornadoes and severe thunderstorms (**Severe thunderstorms are defined as having either tornadoes, wind gusts of at least 58 mph, or hail at least 3/4 inch in diameter**). The National Weather Service has developed a multi-tier concept for forecasting or alerting the public to all types of hazardous weather. (Source: NWS)

	NWS Guidance	Application to FAA Strategic Planning
Outlook	Issued to address hazardous weather and provide the information to those who need considerable lead time	SCC ,AOC's, and ARTCC's review staffing. SCC Coordination with NavCanada and Military for potential routing options.
Watch	risk of hazardous weather has increased and to provide enough lead time so those who need to set their plans in motion can begin to do so	SCC and AOC's have a pre-coordinated plan of action for delay mitigation today. High probability of TMI's. Action plan/rates shared
Warning	is issued when hazardous weather is occurring, imminent or likely	SCC action plan implemented at 6hr timeframe
Advisory	is issued when hazardous weather is occurring, imminent or likely. Is for less serious conditions than warnings	SCC strategic planning subsumed by tactical operations



TFM Weather Management Matrix: Issuing the NAS Critical Event Statement (ATCSCC Advisory)

Example of Event-Driven Scenario and Incremental Decision Making

Increasing risk as a function of time

Critical Decision Point for Daily Strategic Planning

Statement	Lead Time	Certainty of Event	Outcome
<p>Outlook: Review of extended weather forecast data to determine if TFM scenario modeling will be necessary later today. Planning phase of Strategic Management to obtain NAS efficiency.</p>	<p>10-12hrs with a maximum of 24hrs. Wx data updates at 06z. Key timeframe for establishing TFM strategy scenarios for coming day.</p>	<p>High probability of convective weather disruption based on review of weather forecasts (e.g., SPC Convective Outlook, Thunderstorm Probability, LAMP,)</p>	<p>TFM Programs possible today, disseminates ATCSCC intentions so stakeholders can plan accordingly. FAA considers staffing needs for time period. Coordinate with NavCanada and Military for routing options/possibilities.</p>
<p>Watch: Early Morning SPT issues TFM "Watch statement" to customers for probability of programs today. (Wx/Impact Translation)</p>	<p>At least 8hrs prior if updated weather forecast continues to favor a convective outbreak based on the "Outlook" statement above.</p>	<p>Risk of convective weather continues to be evident or increased in likelihood based on probabilistic data. This supports TMI modeling, airspace availability, traffic demand.</p>	<p>Stakeholders plan for high probability of numerous TMI's today. Consider reroute options, fueling needs and deploy accordingly. Action plan is shared but not executed.(no traffic moved)</p>
<p>Significant: TFM programs GS, GDP, AFP's are incorporated. Traffic has option to reroute at this point. (Current 6hr Ops Plan time)</p>	<p>At least 6hrs prior based on CCFP 6hr forecast indicating convective weather within the same areas indicated by the "Watch" and "Outlook"</p>	<p>Forecast continues to show evidence of convective and/or imminent weather with a high probability of occurrence</p>	<p>Requires immediate action by customers to protect respective schedules. Implementation of programs by ATCSCC</p>
<p>Warning: To advise that the strategic plan will be subsumed by the tactical plan and operations. (Tactical Planning begins)</p>	<p>At least 4hrs or less based on an increase in relevant info, forecast confidence and or coverage.</p>	<p>Convective initiation about to or beginning to occur with a high probability of increasing intensity and/or coverage</p>	<p>Requires action to protect against delays based on strategic planning coupled with tactical planning "Exit Strategy"</p>



Traffic Management Advisory

(Source: Air Traffic Control System Command Center)

ATCSCC Advisory

ATCSCC ADVZY 026 LGA/ZNY 10/21/2008 CDM GROUND DELAY PROGRAM

MESSAGE: CTL ELEMENT: LGA
ELEMENT TYPE: APT
ADL TIME: 2208Z
DELAY ASSIGNMENT MODE: DAS
ARRIVALS ESTIMATED FOR: 21/2208Z - 22/0359Z
CUMULATIVE PROGRAM PERIOD: 21/1536Z - 22/0359Z
PROGRAM RATE: 30
FLT INCL: ALL CONTIGUOUS US DEP
DEP SCOPE: 1450
ADDITIONAL DEP FACILITIES INCLUDED:
CANADIAN DEP ARPTS INCLUDED: CYHZ CYOW CYUL CYYZ CYTZ CYQB
DELAY ASSIGNMENT TABLE APPLIES TO: ZNY
MAXIMUM DELAY: 633
AVERAGE DELAY: 84.9
IMPACTING CONDITION: WEATHER / WIND
COMMENTS: LANDING AND DEPARTING RWY 31. GDP REVISED AND EXTENDED
UNTIL 0359Z. GROUND STOP CANCELLED WITH NEW EDCT'S.

**IMPACTING CONDITION:
WEATHER / WIND**

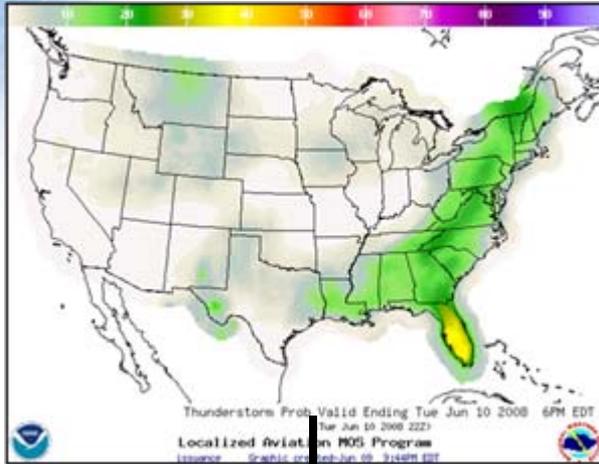
EFFECTIVE TIME: 212209 - 220459

SIGNATURE: 08/10/21 22:10



Weather Forecast Information Available 12-24 Hours Out [OUTLOOK]

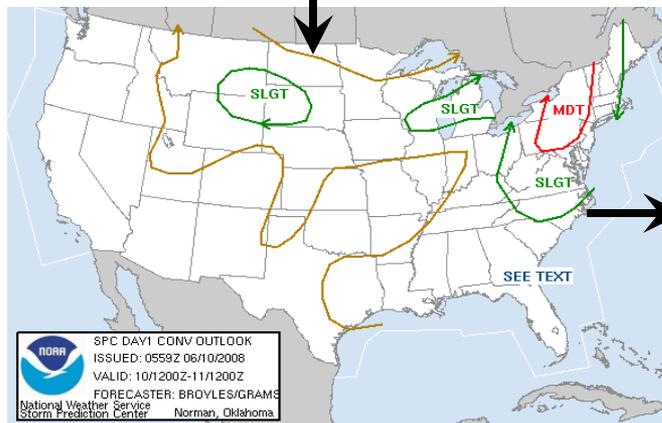
Automated Probabilistic



- Forecast information available in the overnight hours
- The SPC Forecast for SLGT Risk is updated at 06z and now includes a MDT Risk area.

This is an example of increasing risk for capacity constraints in the NAS later today.

- Results in an “OUTLOOK” (NAS Critical Event Statement) being issued to promote common situational awareness between command center and stakeholders



HITL Deterministic

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/Props, SPC Day 1 Convective Outlook	TFM Programs possible: Provides for ATCSCC Traffic Management intentions to filter through weather forecast. ARITCC'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 TMs 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

“**Outlook**” issued by ATCSCC as (NAS Critical Event Statement) based on worsening forecast conditions issued at 0600z



Weather Forecast Information Available 8-12hrs Out

Local NWS Forecast Office Discussions

AREA FORECAST DISCUSSION NATIONAL WEATHER SERVICE TAUNTON MA (BOS) 410 AM EDT TUE JUN 10 2008

CONVECTION WILL BE DELAYED UNTIL 5-8 PM FOR WESTERN PORTIONS OF CT AND MA...AND PROBABLY NOT UNTIL AFTER 8 PM FOR EASTERN MA AND RI.
IT APPEARS THE GREATEST RISK FOR SEVERE WEATHER WILL BE EARLY THIS EVENING ACROSS WESTERN PORTIONS OF CT/MA AND INTO SOUTHWEST NH...WITH A WEAKENING LINE OF CONVECTION TRAVERSING EASTWARD.
AMOUNT OF INSTABILITY COMBINED WITH SUFFICIENT SHEAR TO ORGANIZE CONVECTION AND MODEST LOW LEVEL CONVERGENCE AHEAD OF THE FRONT SHOULD YIELD **WIDESPREAD CONVECTION ACROSS WESTERN PORTIONS OF CT/MA INTO SW NH THIS EVENING...** WITH THE POTENTIAL FOR STRONG TO SEVERE STORMS.

AREA FORECAST DISCUSSION NATIONAL WEATHER SERVICE ALBANY NY (ALB) 650 AM EDT TUE JUN 10 2008

EXTENSIVE REVIEW OF NUMEROUS CONVECTIVE PARAMETERS CONFIRMS WITH SPC ASSESSMENT OF WIDESPREAD SVR WIND AND ISOLD TORNADOES POSSIBLE WITH THIS FROPA. CAPES ARE ALREADY NORTH OF 2500 J/KG AND CAP WILL ERODE. TT WILL BE IN THE 50-55 RANGE...
CIN WILL BE SIGNIFICANT INTO THE EARLY AFTN THEN ERODE QUICKLY CAPPING THINGS LONG ENOUGH TO RESULT IN A MORE EXPLOSIVE DEVELOPMENT WHEN IT GOES.... LI OF NEG 6
THIS EVENT IS ALL FROPA AND CAPE DRIVEN...**SUPER CELLS BCM A LINEAR CONVECTIVE LINE/SQUALL LINE OF SOME SORT. TSTMS WILL FIRE ALONG OR AHEAD OF CDFNT...AND QUICKLY BCM SVR. WIDESPREAD SVR TSTM OUTBREAK EXPECTED TODAY.**

AREA FORECAST DISCUSSION NATIONAL WEATHER SERVICE UPTON NY (OKX) 502 AM EDT TUE JUN 10 2008

A PRE-FRONTAL TROUGH IS FORECAST TO DEVELOP ACROSS CENTRAL PA THIS AFTERNOON AND SLIDE EASTWARD INTO WESTERN PARTS OF THE CWA BY LATE IN THE DAY. THE ATMOSPHERE WILL ONCE AGAIN BECOME HIGHLY UNSTABLE WITH SB CAPE VALUES BETWEEN 1500 AND 2500 J/KG... LI'S BETWEEN -4 AND -7 AND TOTAL TOTALS IN THE LOWER 50S
UNIDIRECTIONAL SHEAR INDICATES SQUALL/BOWING SEGMENTS WHICH WOULD BE CAPABLE OF PRODUCING DAMAGING WINDS

AREA FORECAST DISCUSSION NATIONAL WEATHER SERVICE MOUNT HOLLY NJ (PHL) 410 AM EDT TUE JUN 10 2008

THE FRONT WILL REACH THE COAST AROUND SUNDOWN ACCOMPANIED BY HEAVY THUNDERSTORMS THAT WILL LINGER PAST MIDNIGHT.
STAY TUNED TODAY IN THE EVENT A SEVERE THUNDERSTORM WATCH IS ISSUED FOR THE REGION FOLLOWED POSSIBLY BY WARNINGS.
STORMS ARE ALREADY INTO THE OHIO VALLEY AND EXTEND SOUTH TO TENNESSEE. THESE WILL MOVE EAST AHEAD OF AN APPROACHING COLD FRONT.

AREA FORECAST DISCUSSION NATIONAL WEATHER SERVICE BALTIMORE MD/WASHINGTON DC (IAD) 337 AM EDT TUE JUN 10 2008

THE HEAT AND HUMIDITY WILL HELP TO IGNITE SCATTERED THUNDERSTORMS AHEAD OF A COOL FRONT THIS AFTERNOON AND EVENING BEFORE THE FRONT MOVES THROUGH OVERNIGHT. THUNDERSTORMS WERE ALREADY ROTATING AROUND THE PERIPHERY OF THE RIDGE IN A RING OF FIRE EARLY THIS MORNING. THUNDERSTORMS WERE MOVING NORTH//NORTHEAST THROUGH THE TENNESSEE AND OHIO VALLEYS WITH THE AID OF STRONG ADVECTION AND IN STABILITY. MOST OF THIS ACTIVITY WILL REMAIN TO OUR WEST THIS MORNING.
CONVECTIVE INITIATION WILL LIKELY OCCUR BY 18Z NEAR OR JUST WEST OF THE BLUE RIDGE. THEN WILL PROPAGATE EAST.
ANY BOUNDARIES FROM CONVECTION TO THE WEST THIS MORNING AND THE LEE TROUGH WILL SERVE AS EFFECTIVE INITIAL TRIGGERS. STORMS WILL BE SCATTERED



Event Day: 1115z / 0715 EST

CCFP CHAT Session with 8hr Outlook [WATCH]

- Chat for 11Z CCFP Issuance

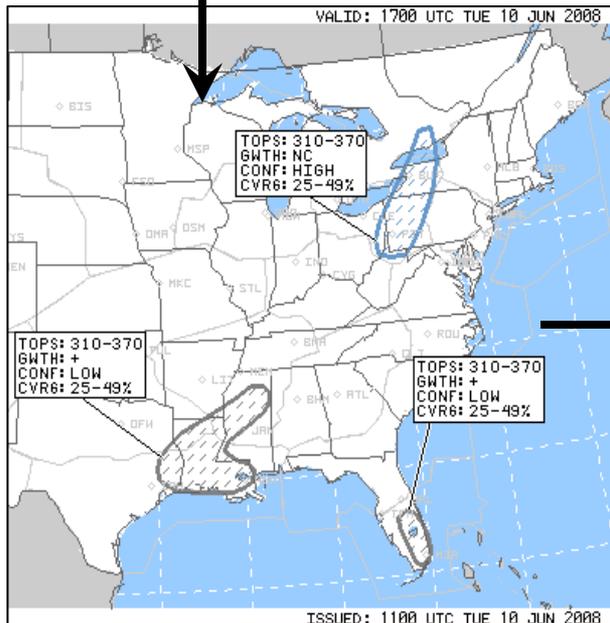
- AWC-Forecaster 10:11:02Z

Good morning. Ts over OH is will probably weaken somewhat this morning as LLJ diminishes, but increased lift associated with apchg upr trof and entrance region of H5 jet movg acrs OH thru 17Z shld sustain some convection into PA and NY. Ts over nern TX into nwrn LA near sfc bndry is likely to cont and may increase again closer to weak H5 low and sfc trof over MS into nern LA midday. Ts appears likely to dvlp by around 17Z over FL near sfc low. **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.**

- CCFP OUTLOOK time is now out to 8hrs
- Outlook is only in the chat based on FY07 MITRE research

CCFP is the primary planning tool for TFM. This is another decision tool that is confirming the increasing risk for capacity constraints in the NAS later today. Supports the first collaborative Planning Telcon of the day.

- Results in “WATCH” (NAS Critical Event Statement) being issued to promote common situational awareness between command center and stakeholders



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
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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

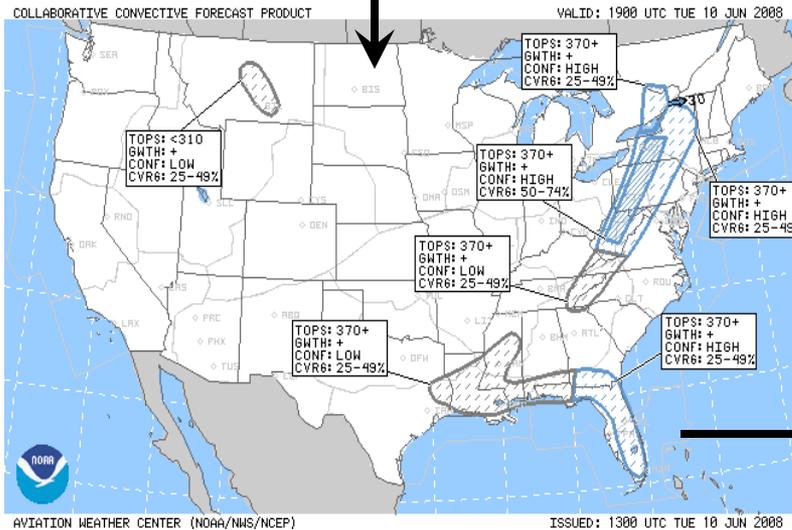
“Watch” Statement issued based on CCFP Forecast, TFM Program modeling should occur between the Outlook and Watch so modeling results are known while in the Watch tier.



Event Day: 1315z CCFP and Planning Telcon [SIGNIFICANT]

- **AWC-Forecaster 12:12:27Z**
Good morning. Convection has diminished a bit faster than expected over OH and PA and this trend will probably cont short-term, but ts shld begin to increase again late morning as H5 jet strengthens over OH, wrn PA and wrn NY ahead of shortwave trof and ams destabilizes along outflow bndry over wrn PA. This pattern shld cont thru 19Z with ts expected to dvlp swd into WV and along the Appalachians. **OUTLOOK 21Z thru early evening is for ts to cont fm ern TN, GA, NC and VA nwd to New England. Greatest coverage is expected over MD / VA nwd to ern ptns of PA and NY into VT**

- CCFP now confirming what was mentioned on the 11z 8hr preview.
- Modeled AFP to start at 17z AFP 5 avg 58min and 8 avg 28 min. A761 (WATRS Route). CAN 7 to be utilized
- AFP 5 and 8 being implemented at this time. Command Center mentioning westbounds out of NY this evening will be routed south and then turned west.



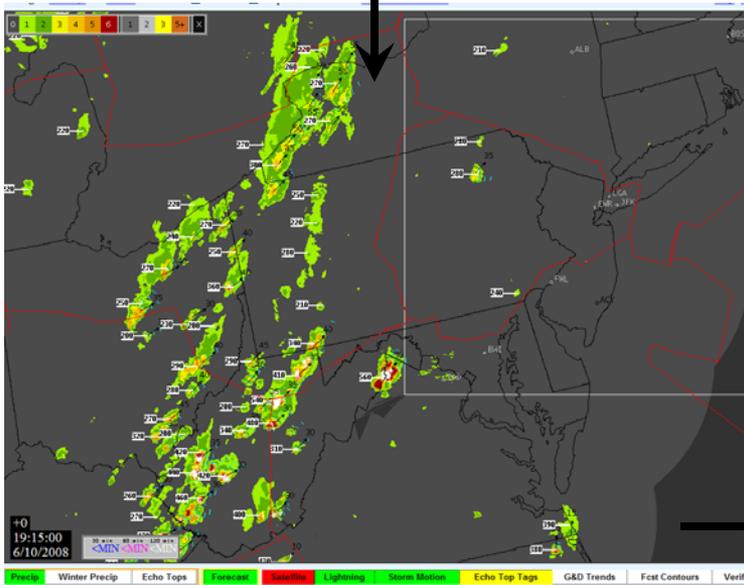
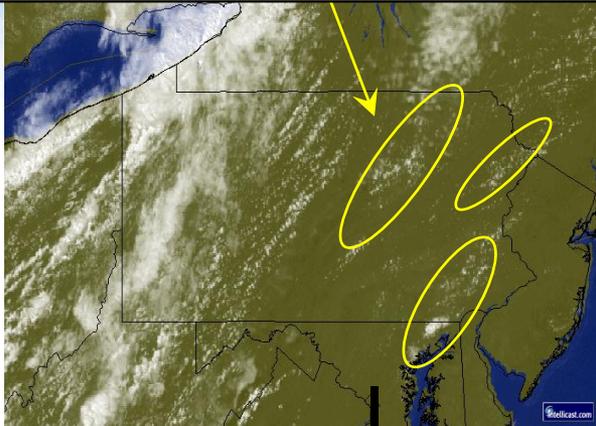
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Watch: Early morning SPT issues TFM Watch/Advisory to customers for probability of program today (Wx/Impact Translation)	At least 8 hrs prior if weather forecast continues to favor a convective outbreak based on Outlook statement	Risk of convective 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 TMLs are highly probable today. Plan of action is shared but not executed (no traffic moved).
Significant: TFM programs GS, GDP, AFP are implemented. Traffic has option to reroute at this point	At least 4 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 ATCSOC
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

Based on 13z updated wx and CCFP
"Significant"
Impact Statement released so implementation of TFM programs and alternate routing can begin well in advance of convective initiation

Event Day: 1845z-1915z

Convective Initiation [WARNING]

Anticipate arrival and departure flows based on convective mode and axis of orientation with tactical tools to mitigate large scale delays



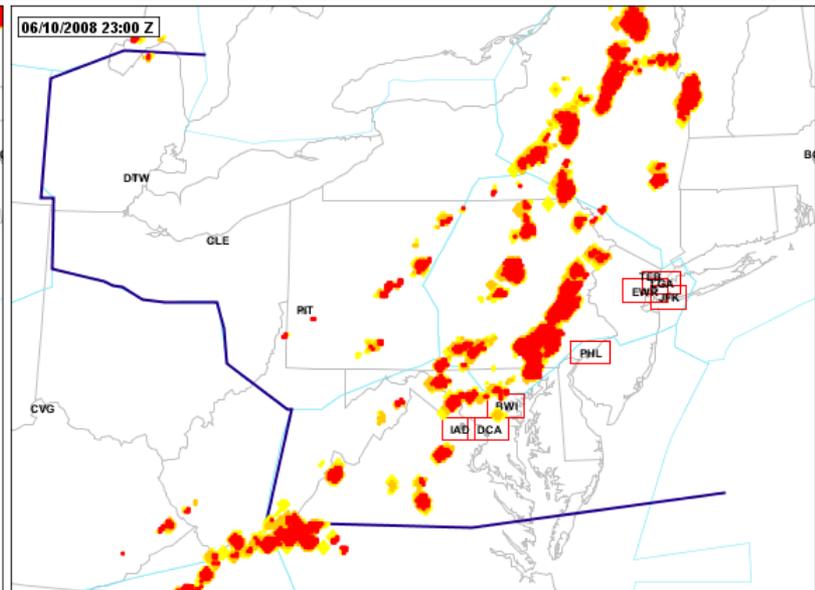
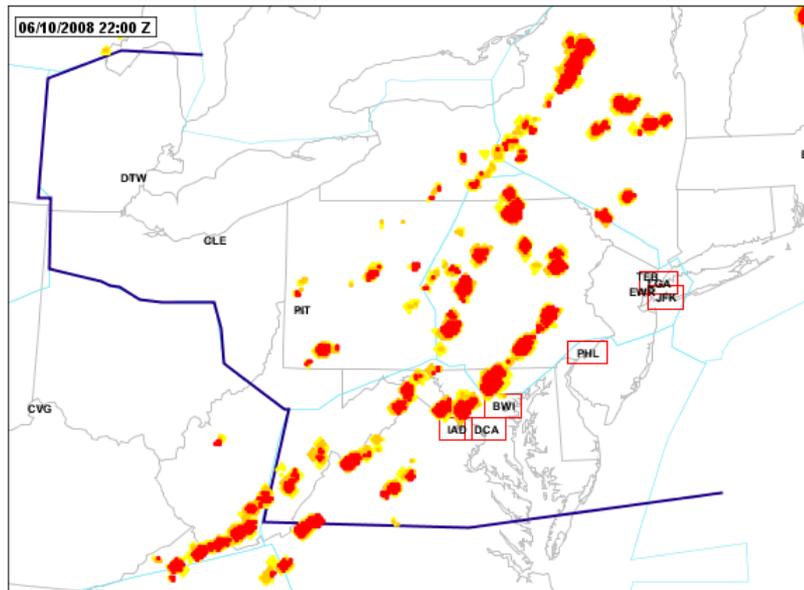
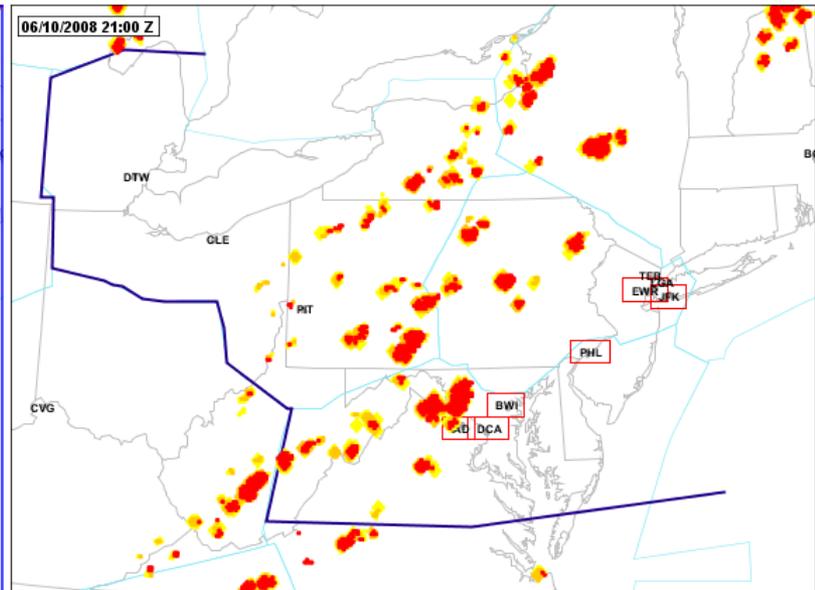
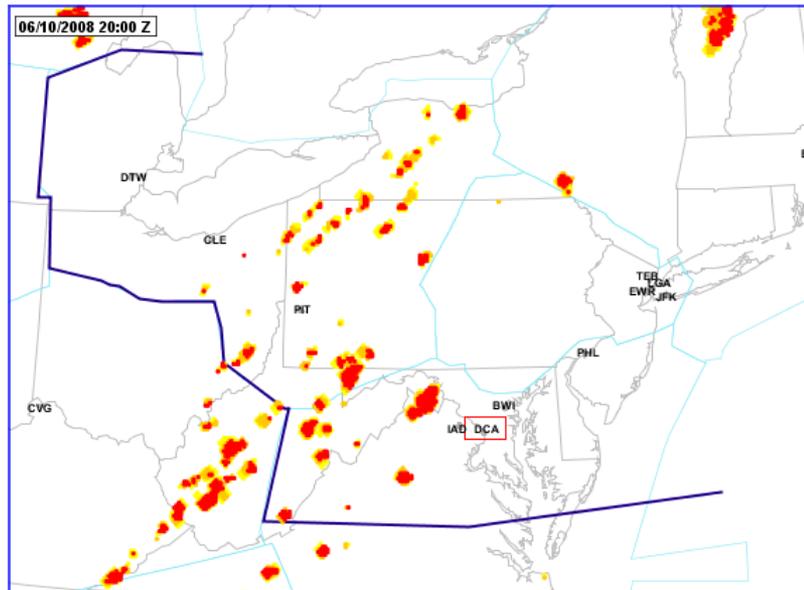
- Until this point, Command Center and Customers satisfied with routing and flow rates
- Upon entering the tactical realm of traffic flow management, from this point forward, risk of constraint will increase exponentially over a short period of time

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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

“Warning”
Statement should be issued for tactical planning to commence as airways become blocked. Anticipate arrival and departure flows with tactical tools to mitigate large scale delays



20z-23z

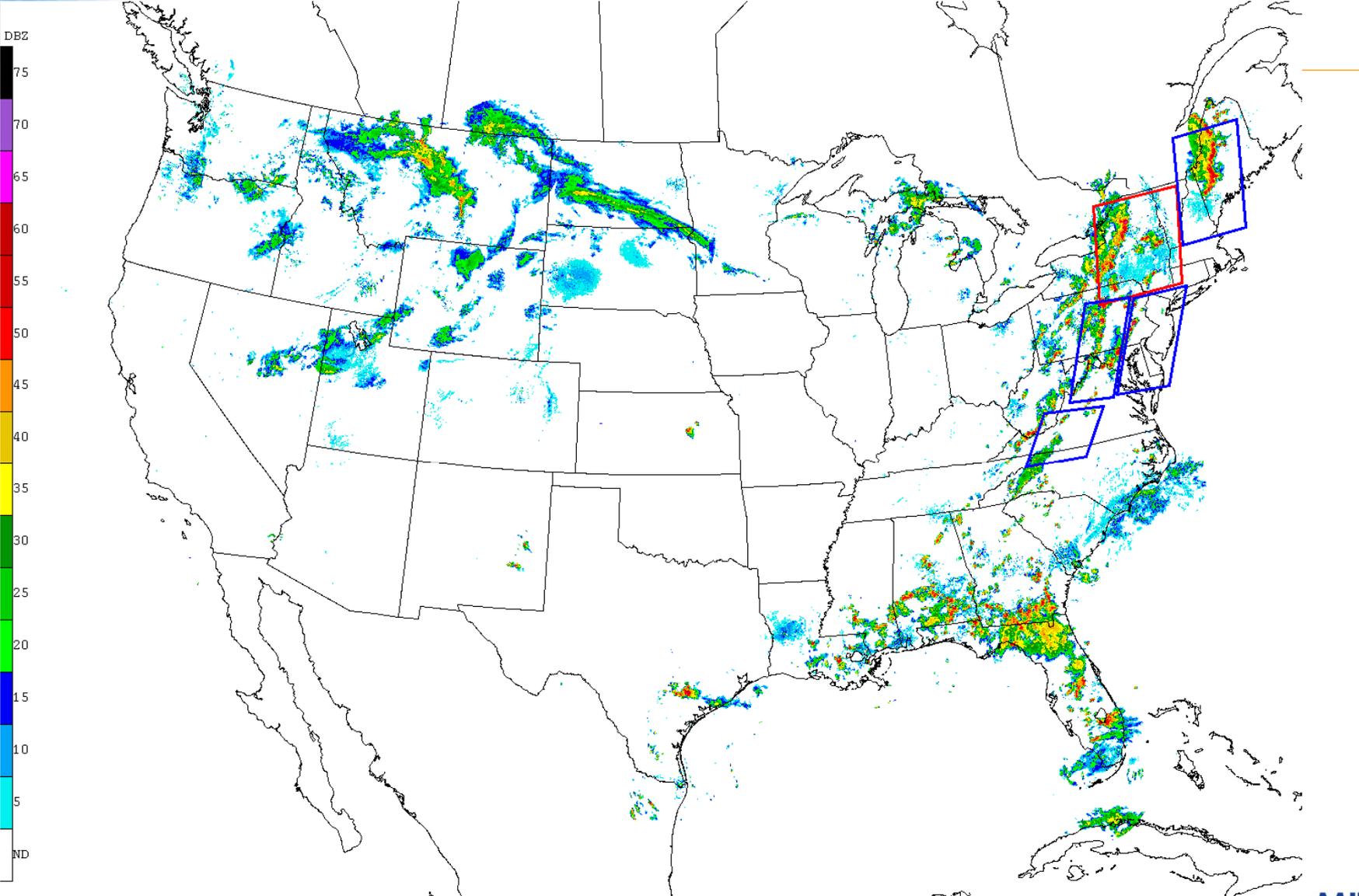


FCA08 - NF
FCA05 - NF

DCA: GS-THUNDERSTORMS



2200 UTC Base Reflectivity 10 June 2008



080610/2204 NATIONAL 2 KM BASE REFLECT 0.00 DEG



NAS Critical Event Statement

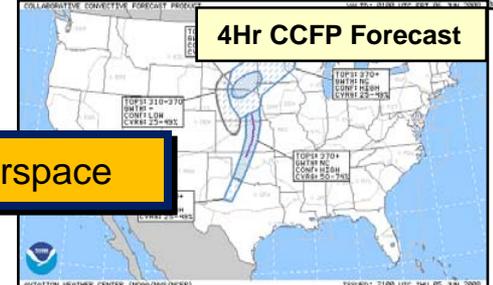
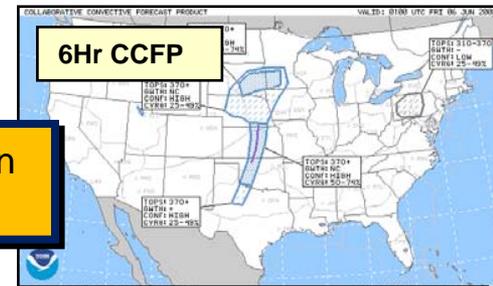
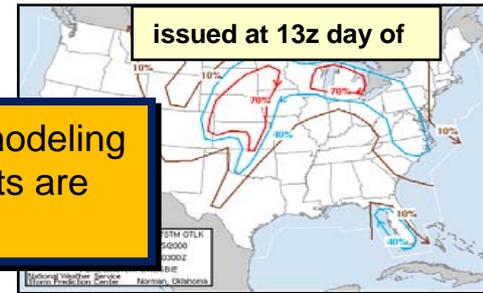
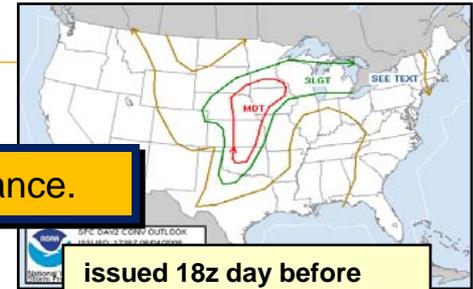
Statement	Lead Time	Certainty of Event	Outcome
<p>Outlook: Overnight weather forecast determine if TFM scenario modeling will be necessary for strategic management</p>	<p>Approximately 12-18 hours</p> <p>is a key time period to start establishing a TFM strategy for the coming day</p>	<p>High probability of weather forecast. Reference data such as Jet Stream, Surface Analysis/Progs, SPC Day 1 Convective Outlook</p>	<p>Intentions to filter through ARTCC's and customers so all stakeholders can plan and deploy accordingly</p>
<p>Watch: Early morning SPT issues TFM Watch/Advisory to customers for probability of programs today (Wx/Impact Translation)</p>	<p>Statement based on Outlook</p>	<p>Based on probabilistic forecast data</p>	<p>TFM are highly probable today. Plan of action is shared but not executed (no traffic moved).</p>
<p>Significant: TFM programs GS, GDP, AFP's are implemented. Traffic has option to reroute at this point</p>	<p>weather within the same areas indicated by the "Watch" and "Outlook"</p>	<p>with a high probability of occurrence</p>	<p>Implementation of programs by ATCSCC</p>
<p>Warning: Incorporate this into TFM impacts and or solution set. (Tactical Planning begins)</p>	<p>At least show in and or coverage.</p>	<p>high probability of intensification</p>	<p>and handling of arrival and departure flows</p>

"Outlook" Convective weather potential issued 12 or more hours in advance.

"Watch" Increasing risk of convective weather. TFM program modeling should occur between the Outlook and Watch so modeling results are known to stakeholders while in the Watch tier.

"Significant" Validated by 6 Hr CCFP to initiate implementation of traffic management initiatives

"Warning" Initiates tactical management of constrained airspace





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