INTEGRATING IMPROVED WEATHER FORECAST DATA WITH TFM DECISION SUPPORT SYSTEMS

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1. OVERVIEW

During the severe weather season, generally encompassing the months of March through October, the Federal Aviation Administration (FAA) and National Airspace System (NAS) customers collaborate on strategies to minimize the disruption convective weather has on traffic flows. After many observations of transcontinental rerouting decisions, a *Transcon Options* paper was published in the *Journal of Air Traffic Control*, April 2004. The proposal suggested that on days when convective weather was forecast over large areas of the eastern states, departures from western airports would file flight plans for customer preferred routings to decision point(s) west of the forecast weather area and then include a reroute around the forecast weather area along a Constraint Avoidance Route to Destination (CARD). If weather develops, aircraft are afforded the opportunity to operate along customer preferred routes for at least a portion of their flight. If the weather does not develop and only if controller workload permits, air traffic control (ATC) could allow flights to continue through the forecast weather area.

As proposed, the *Transcon Options* concept allows customers to operate their flights along customer preferred paths for most of their flight. This paper suggests that by using existing and integrating improved weather forecast products with Traffic Flow Management (TFM) Decision Support Systems (DSSs), flow managers and customers can better collaborate on reroutes to avoid weather and provide the customer with fuel efficient routing alternatives.

2. AVAILABLE WEATHER PRODUCTS

There are many challenges associated with predicting en route thunderstorm location and movement. Two products produced by the Aviation Weather Center are the automated National Convective Weather Forecast (NCWF) 1-hour forecast and the Collaborative Convective Forecast Product (CCFP) 2-, 4-, and 6-hour forecasts which are updated every two hours.

A third, called the Corridor Integrated Weather System (CIWS), provides 2-hour animated growth and decay forecasts of storms. CIWS uses inputs from terminal and en route weather sensors. It synthesizes rapid update Airport Surveillance Radar weather data with NEXRAD radar data which provides a 3-dimensional storm structure. Future plans call for the integration of weather data from Terminal Doppler Weather Radar and Canadian Radars.

CIWS provides accurate, automated, high update rate information on storm locations and echo tops, along with a 2-hour forecast.[1] (Figure 1)

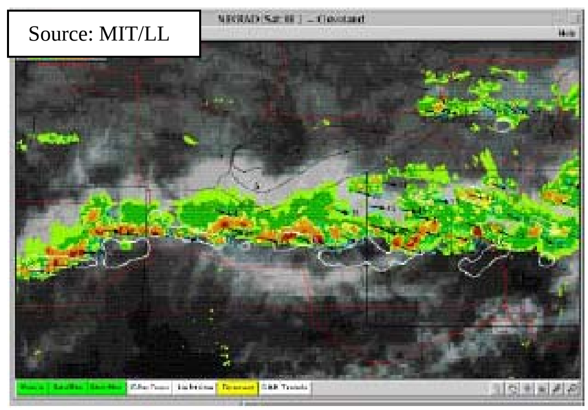

Figure 1: CWIS Weather Forecast

[1] Corridor Integrated Weather System (CIWS), http://www.ll.mit.edu/AviationWeather/CIWS-flyer.html

Although somewhat limited in geographic coverage (Figure 2), CWIS provides forecasts for many of high volume traffic areas of the NAS. The depicted CIWS coverage area includes the major northeastern airways, as well as many of the high volume terminal areas to include Boston, Chicago, and the New York and Washington metropolitan airports

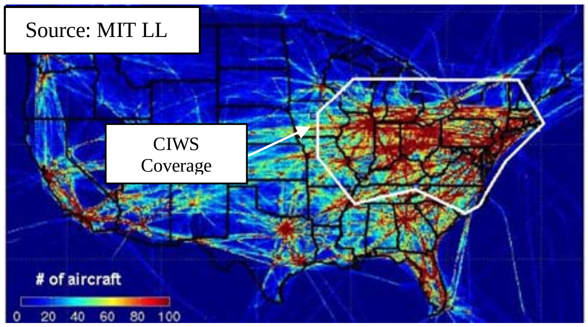

Figure 2: CWIS Coverage

3. TFM DSS/WEATHER PRODUCT INTEGRATION

The existing TFM DSS called the Enhanced Traffic Management System (ETMS) Traffic Situation Display (TSD) depicts the NCWF and CCFP. Although available, NCWF is generally not discussed during severe weather routing collaboration sessions. We believe the reason is flow managers prefer forecasts that are greater than the NCWF one hour look ahead. The CCFP is used by the FAA Air Traffic Control System Command Center (ATCSCC) Planning Team and customers. However, there is considerable uncertainty associated with its predictions making it very challenging for flow managers and FAA customers to develop a collaborative decision on reroutes.

The National Oceanic and Atmospheric Administration (NOAA) Forecast Systems Laboratory (FSL) Real Time Verification System example (Figure 3) shows the 13Z, 4-hour CCFP and actual weather on July 19, 2005, a day the ATCSCC implemented traffic management initiatives to reduce the flow of west to east traffic due to forecast convective weather. We chose this 4-hour forecast because it takes departures from airports in the western states 3 to 4 hours to reach weather areas east of the Mississippi River. Forecasts less than 4 hours into the future are of little help because traffic flow managers prefer customers to include any rerouting changes in their pre-departure flight plan.

The CCFP prediction shows several areas of low confidence forecast convective weather. The green areas depict the actual weather locations at the forecast time. It is fairly evident, that weather did not materialize in some areas where it was expected. It is also evident that weather formed where it was not predicted.

CCFP integration with TFM DSS has been very useful. Depicting forecast weather and possible

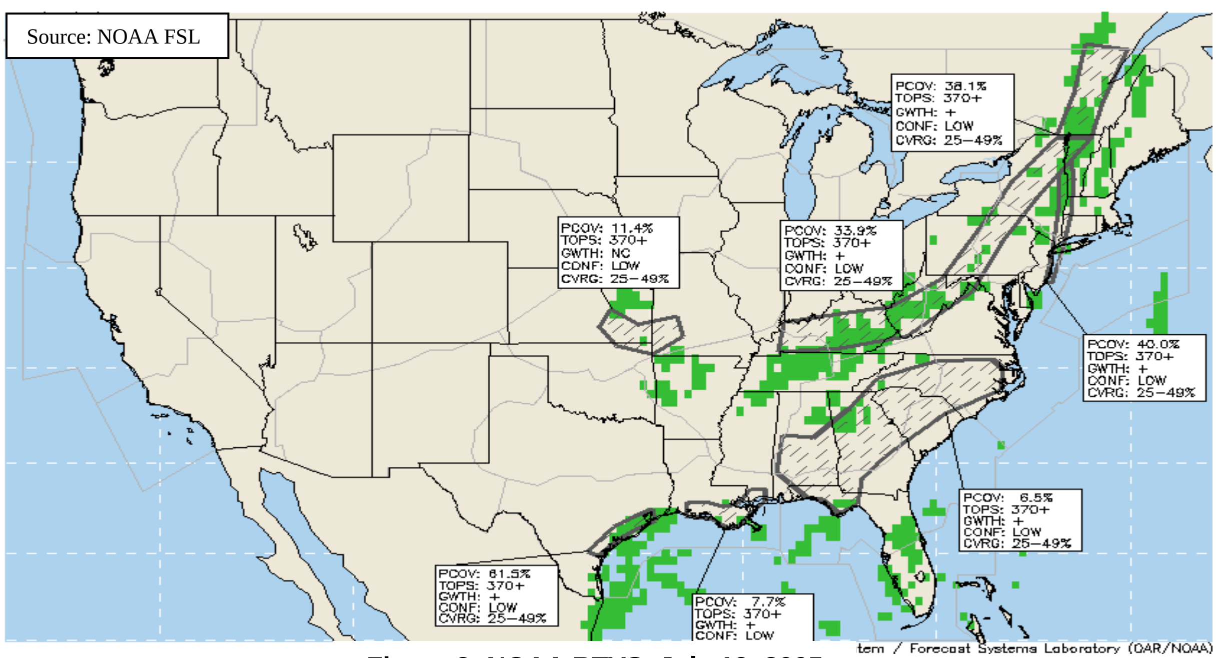

Figure 3: NOAA RTVS, July 19, 2005

reroutes on the same display permit flow managers to better visualize ways to organize flows around forecast weather. Nevertheless, the additional integration of forecast products namely CIWS would be very beneficial as long as the forecast weather data is presented graphically along with route alternatives. The goal is to reduce coordination by displaying solutions to system impacts and providing common situational awareness.

3.1 Integration Concept

MIT Lincoln Laboratory (MIT/LL) has developed a prototype Route Availability Planning Tool (RAPT) that presents CIWS weather and traffic management information on a single display[2] (Figure 4). The impact of the weather hazard is presented in relation to aircraft route of flight. ***The presentation is operationally beneficial because it supplies the operator with information results. There are no mental calculations required.***

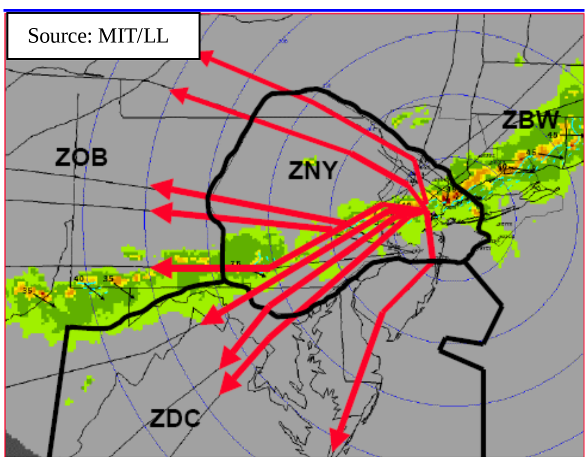

Figure 4: RAPT Depiction

4. PROPOSED APPLICATION

A description of the *Transcon Options* concept to show how CCFP and CIWS can be used to help flow managers and customers define severe weather reroutes follow.

4.1 Defining Route Alternatives

When the CCFP is issued and there is a decision to take a rerouting action, the FAA and customers identify flights that may be impacted by a rerouting action. Using TSD, ATCSCC personnel define a decision area by depicting a range ring that is some agreed upon distance from the constraint (e.g., 400 nautical miles). They then define a shared Flow Evaluation Area (FEA) along the ring to identify flights planned to traverse the decision area. This enables FAA facilities, using the TSD, and NAS customers, using the Common Constraint Situational Display (CCSD), to identify flights that may be impacted by a rerouting action.

ATCSCC personnel then define a set of decision points that are in or adjacent to the FEA. Command Center personnel also define CARDs consisting of routing options to avoid the forecast weather area. The CARDs may avoid the CCFP forecast area. However, if the CCFP forecast area is within CIWS coverage, the CARDS would be defined and updated using a CWIS forecast. With better forecast information the CARDS could include routes through the CCFP forecast area (red depiction) providing customers with a more direct route to destination. Depending on the forecast weather's location in relation to destination airports, the CARD could join an ATC preferred or other ATC assigned route to destination (Figure 5).

2 MIT Lincoln Laboratory, Corridor Integrated Weather System (CIWS) J. Evans 9/24/2002

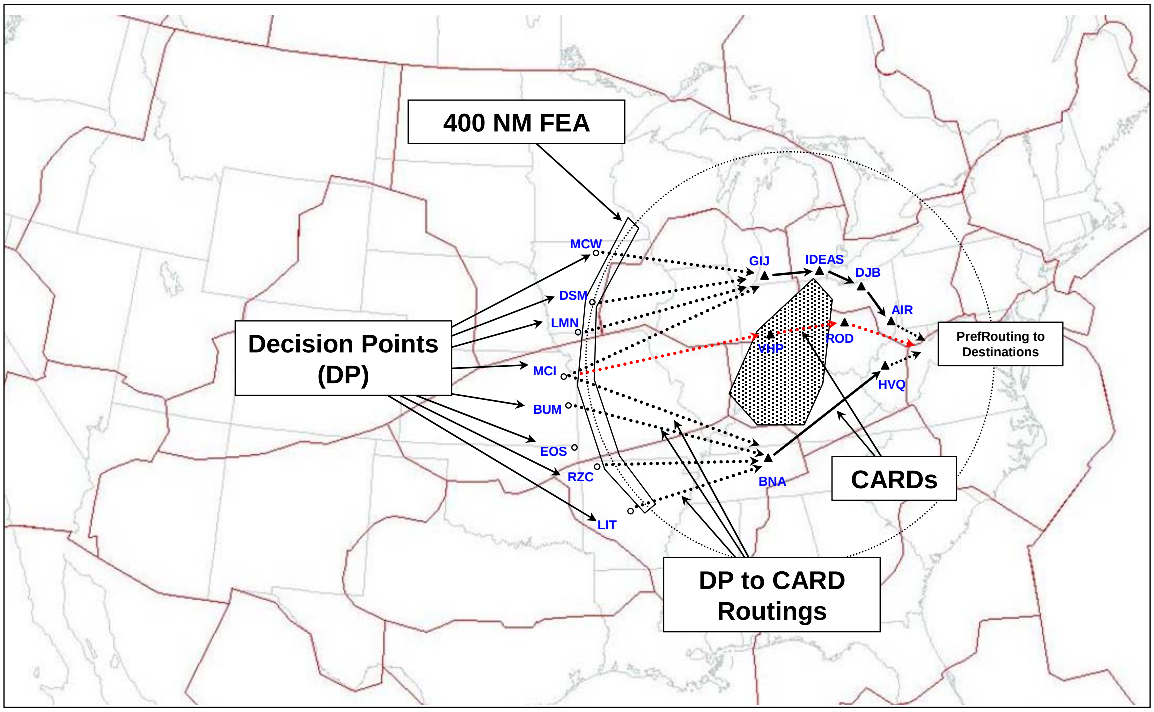

Figure 5: Rerouting Alternatives

4.2 Selecting Routes

On a day when ATCSCC planners and customers agree that CCFP forecast weather suggests the implementation of *Transcon Options* is appropriate, flights operating between agreed upon Air Route Traffic Control Center (ARTCC) and/or city pairs and predicted to traverse the decision area file customer-preferred routings to a decision point of their choice and then along a pre-departure CARD to their destination. Using CWIS forecasts, flow managers update the CARDs to avoid forecast areas of convective weather which in many cases will traverse the CCFP forecast weather area.

Since customers have already filed flight plans to avoid the weather no rerouting of airborne aircraft is needed. As flights near their decision point, new CARDs may become available. If, and only if controller workload permits, some flights may be routed through the area where severe weather had been forecasted, thus possibly receiving a customer-preferred routing from departure to destination.

4.3 Management of Flows Using the National En Route Spacing Position (NESP)

The ATCSCC National En Route Spacing Position (NESP) was staffed on July 19, 2005; a day the Command Center executed a strategy to reduce en route traffic volume over the eastern states. Reroutes were defined with 50 miles-in-trail (MIT) restrictions and customers were permitted to select a route of their choice. The NESP monitored route demand and notified customers of expected delays on a particular route. Anticipated delays were calculated using the MITRE Center for Advanced Aviation Systems Development (CAASD) Analysis Platform for En Route (CAPER).

A similar strategy could be used to manage *Transcon Option* flows. ATCSCC personnel would publish CARD routings and customers would choose a routing alternative. The NESP would monitor demand by constructing an ETMS FEA at an applicable decision point. This data would be shared with customers through the CCSD and customers would be permitted to change their filed routes based on predicted demand. If demand necessitates the use of MIT restrictions, CAPER could be used to provide delay information. Customers could use this information to decide on alternative routing strategies.

5. SUMMARY

We can implement the *Transcon Options* proposal with existing capabilities and minimum procedural changes. It does require the manual definition of routes to avoid forecast convective weather and areas of high demand. It is hoped that this concept be employed during the 2006 severe weather season.

Automating the route definition and demand prediction process would be the next logical step. Ongoing CAASD research is exploring methods to provide the desired automation assistance. Probabilistic, Automation-Assisted, Congestion Management for En Route (PACER) allows flow managers to retrieve reroutes from a database of previously defined and saved routes. It also provides probabilistic forecasts of the impact on sector capacity when convective weather is present.

Nevertheless, new weather products should be integrated with TFM DSS as they become available if an operational benefit exists. The MIT/LL integration approach where the impact of forecast weather is readily apparent to the flow manager is an excellent example of future integration techniques. The product should provide flow managers and customers with a simple and understandable depiction of forecast weather, route impact, and route alternatives.

6. REFERENCES

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