ATLANTA HOLDING CASE STUDY: IDENTIFYING A NEED FOR THE ADVANCEMENT OF EN ROUTE METEOROLOGY PROGRAMS

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1. INTRODUCTION

A case study was conducted on the commercial air traffic holding at the Atlanta Hartsfield- Jackson International (ATL) airport from 1 October 2002 through 30 September 2003. The purpose of the study was to quantify the effects Center Weather Service Units (CWSU's) have on traffic movement plans and programs that allow traffic flows within the National Airspace (NAS). During this process, several other findings became apparent, including the opportunity for a redefined CWSU forecast focus on "en route aviation meteorology".

En route aviation meteorology differs from traditional aviation meteorology in that it shifts the focus from the pilot as the primary user, to the air traffic controller. This shift makes traditional terms, such as Visual Flight Rules (VFR), Marginal Visual Flight Rules (MVFR), Instrument Flight Rules (IFR), etc., obsolete in the air traffic management profession. The study identified that VFR, IFR and MVFR are not as important as the unique altitude criteria established for an individual airport's maximum traffic flow capability.

Airport traffic flow capability and maximum capability are unique to each major airport, and depending on the number of runways, their configuration, and customer demand. Maximum capability is the number of aircraft an airport can land and depart during a given time frame. What this study refers to as a "push time" is a period which the airports demand exceeds its maximum capability. This is a phenomenon that is common in most major airports in the United States, and is especially a problem at ATL. Weather effects become most critical to aircraft movement and safety during these push times.

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Aircraft and passenger safety become a factor when aircraft are held (put in race track patterns which keeps them from advancing) at major airports and the airspace and altitudes designated for aircraft to hold becomes full. This makes the margin of error for an air traffic controller much smaller. The "big sky" theory has been used as a theoretical philosophy to cushion the fear that a near misses or aircraft collisions may occur, believing that the sky is so large and aircraft are so small that two will never occupy the same space. This theory becomes less acceptable during times of holding when more and more aircraft are placed in the same vicinity. Thus, there is a need to anticipate and alleviate weather-related holding at major airports. Not necessarily just during severe weather events, but during any weather condition that would restrict the ability of a large airport to land aircraft at a normal rate.

2. Case Study Site

Atlanta Hartsfield-Jackson International landed and departed over 1.4 million aircraft which ranked it second in the nation in 2003. It currently has four runways, all oriented east-west, which allows landing approximately 100 aircraft per hour under optimum weather conditions. Operations with all four runways normally allows for continuous landings on the two outboard runways and continuous departures on the inboard runways. All runways have the ability to accommodate category III equipped aircraft (Robinson, 1989) which are allowed to land in Instrument Meteorological Conditions (IMC) as low as ¼ mile of visibility and ceilings as low as 100 feet.

In fiscal year 2003, the ATL airport held 21,876 aircraft for a total of 356,432 total minutes of holding. The average holding time per aircraft was 16.3 minutes. At an industry average of $50.00 per minute to operate a commercial aircraft, the total cost incurred by commercial air carriers for holding alone was approximately $17.8 million. Cost estimates are only for the time the aircraft was officially placed in holding by air traffic control within the Atlanta Air Rout Traffic Control Centers airspace, and does not include any costs incurred by aircraft deviation, aircraft diversion to another airport, aircraft held in an adjoining airspace, ground delays, ground stops, or increased passenger handling costs.

The weather occurring at ATL while each aircraft was placed in holding was recorded and compared, and the total holding time per aircraft was then placed in one of the following categories.

- Visual Flight Rules (VFR)-Ceiling nonexistent or >3000ft, visibility >5mi.
- Marginal Visual Flight Rules (MVFR)-Ceiling 1000ft-3000ft, visibility 3-5mi.
- Instrument Flight Rules (IFR)-Ceiling 500ft-1000ft, visibility 1-3mi.
- Low Instrument Flight Rules (LIFR)-Ceiling <500ft, visibility <1mi.

<table>
<tr><td>VFRNOWX
Ceilings greater than 3000ft.
Visibility greater than 5 mile.
No weather phenomena measured.
Possibly volume related*.
Does not account for slant range related visibility issues.</td><td>MVFR
Ceilings 1000ft-3000ft
Visibility 3-5mi.
Weather related.
May or may not account for a program**.</td></tr>
<tr><td>VFR
Ceilings greater than 3000ft.
Visibility greater than 5 mile.
Weather phenomena was measured.
Possibly volume related*.
Does not account for slant range related visibility issues.</td><td>IFR and LIFR
Ceilings low than 1000ft.
Visibility less than 3mi.
Assumes a program**.</td></tr>
</table>

* Volume refers to any time arrival demand is greater that landing capability for a given time frame regardless of weather.

** Programs are put into place by the FAA Traffic Management Office to restrict and regulate the flow of traffic into the airport due to inclement weather or volume.

Aircraft were initially only categorized based on weather occurring at the landing airport, and did not account for weather occurring at the arrival gates. Arrival gates are en route VOR fix points, radio beacon position locators, through which arriving aircraft enter prior to being transferred to the approach controller for landing. Arrival fix points are usually located on off-cardinal headings (NW, NE, SE, and SW) 40 to 80 mi from a major airport. Departure fixes, similar to arrival fixes, are usually the same distance as arrival gates but are on cardinal headings (N, E, S, and W), thus preventing departure and arrival traffic from interacting.

Thunderstorms and other adverse weather can block these fix points and make them temporarily unusable, especially for arriving traffic. When an arrival fix is lost due to weather, traffic is diverted to another fix point for arrival which will then lower the airport arrival capacity. Aircraft can be placed in holding during such events because of the restricted volume, even though the arrival airport weather may reflect VFR or even clear conditions.

3. Findings

Initial studies categorized all the data into five groups (Fig. 1), based on weather conditions happening at the airport. Contrary to common perceptions, a high percentage (80%) of the holding was conducted during MVFR or better conditions.

Given the cost estimates described above, weather conditions that have traditionally been considered good flight conditions for modern air carrier aircraft

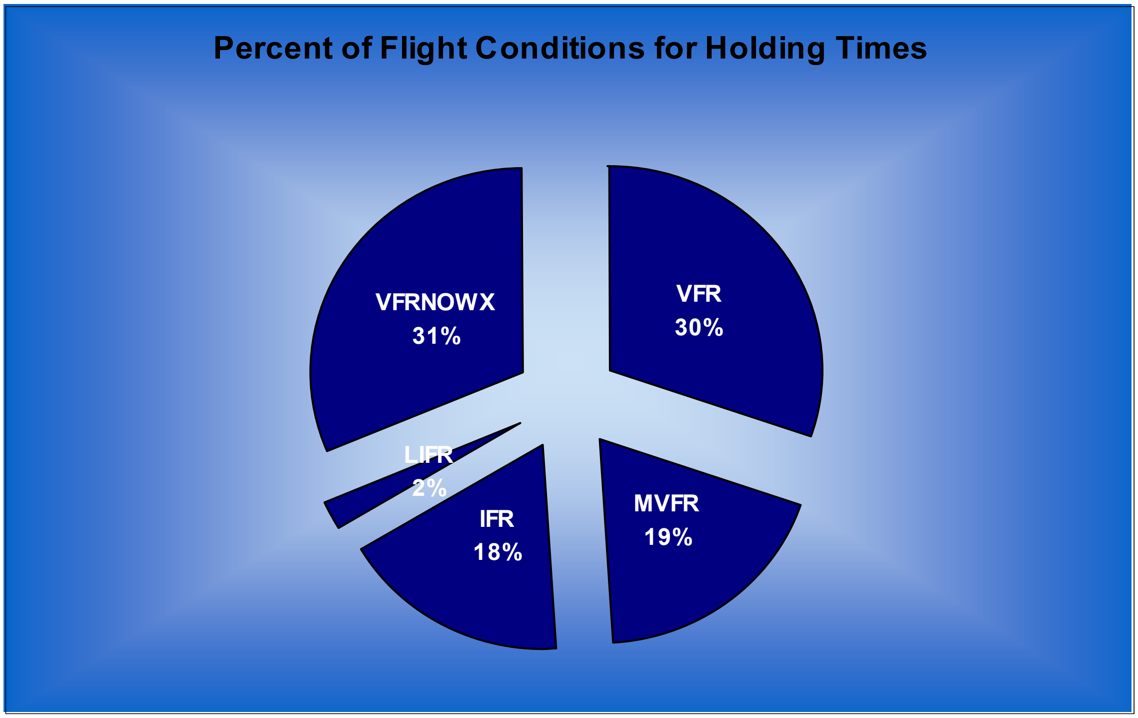

Fig. 1. Percentage of weather conditions during holding.

to operate cost airlines over $14.2 million at Atlanta alone. The discrepancy between airport weather conditions and holding occurrences was thought to be result of severe weather occurring at the arrival gates. However, further investigations of the weather at the four gates during corresponding times proved this suspicion wrong.

A second possibility emerged, that volume could be the sole contributor to holding during days of no weather. A statistical filter was created to estimate the amount of overall holding that was attributed only to volume during times of weather and no weather within the terminal approach area. It was believed that this would yield a relatively high percentage because it was the most likely possibility given the absence of weather, however only 23% of overall holding was attributed to the volume of aircraft at the time of peak

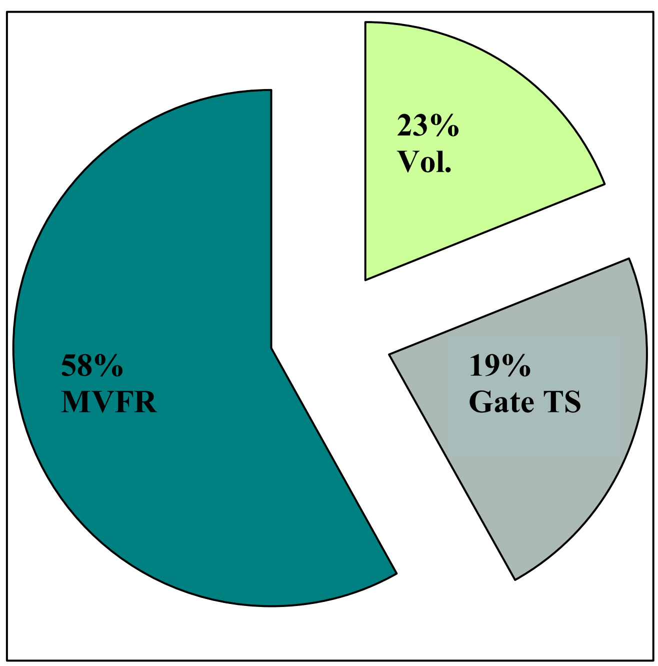

Fig. 2. Gate holding weather conditions.

aircraft holding. After the data were corrected to remove volume-related issues, the result indicated that approximately 62% of the holding was caused by cloud conditions greater than 1000ft and visibilities greater than 3 miles.

A qualitative investigation of why this was occurring showed pilots were not able to maintain visual separation because of scattered or broken cloud conditions below 4500ft. When visual separation was possible, FAA regulations allow aircraft to maintain a 2 mile separation. Without visual separation, the aircraft had to be separated by 2.5 and 3.0 miles dependent on aircraft type. This yields a reduced an arrival rate at ATL by as much as 30%, allowing ATL air traffic controllers to land only 70 aircraft per hour where 100 aircraft per hour normally could have landed. If this sky condition is not anticipated by the aviation forecaster on duty, and no ground delay or flow control programs are put into place, then volume-related issues occur and aircraft are put into holding.

4. Forecast Operations Implementations

Weather Forecast Offices (WFO's) are responsible for the Terminal Aerodrome Forecast (TAF) and its timely issuance. The primary focus of the TAF is on the first few hours of the forecast. New from (FM) group is included when the weather is expected to change categories, (e.g., ceilings go from 2500ft to 900ft, or the visibility decreased from 3mi to less than 1mi). These are national flight condition standards that do not take into account the local approach procedures, approach altitudes and instrument landing equipment requirements unique to each airport.

The following ceiling, visibility, and wind conditions were found through qualitative interviews with traffic management supervisors, to be critically unique to ATL for the aircraft movement decision process:

- Ceilings-
  - >4500ft
  - 3500-4500ft
  - 3000-3500ft
  - 1000-3000ft
  - 500-1000ft
  - <500ft
- Visibilities-
  - >6sm
  - 3-6sm
  - 1-3sm
  - <1sm
- Winds East or West of due North or South -
  - 0-5kts
  - 5-10kts
  - 10-15kts
  - 15-25kts
  - 25+kts

This study identified aviation forecasts that may need more timely updates and more precise decisions. Terminal area forecasts are designed to give the pilot a general idea of the weather conditions at the time of arrival at a particular airport. These conditions do not need to be specific because a commercial pilot will usually rely on the current conditions, for decisions on landing configurations once they are within radio range of an airport. Terminal area forecasts are also used at smaller airports for non-IFR-rated pilots to make their decisions on what flying conditions will be acceptable for their rating.

En route meteorological support to the FAA by Center Weather Service Units can give forecasts customized to the critical thresholds of each major airport. This forecast is well beyond traditional TAF and flight condition criteria. Although the en route meteorological approach may not completely remove holding time for commercial air carriers, it should greatly reduce this input.

Meteorological products for an en route facility and TRACON need to differ from traditional aviation forecast products and take on a more “decision aid” look. Because of increasing demand and the need for time-critical decisions, traffic managers in the FAA do not have the time to read multiple weather products or even decipher face to face weather briefings. Meteorological tactical decision aids can provide real-time and short-term forecasts that provide a yes or no answer as to whether or not aircraft operations will be impacted by forecasted conditions. Fort Worth CWSU has taken a lead in the development of tactical decision aids for traffic managers. An example shown below (Fig.3) shows a crosswind TDA with the color coded limits. Accurate tactical decisions aids may allow a majority of the weather-related decision processes to be automated, providing a green, yellow, and red indicator for each weather element on an hourly basis.

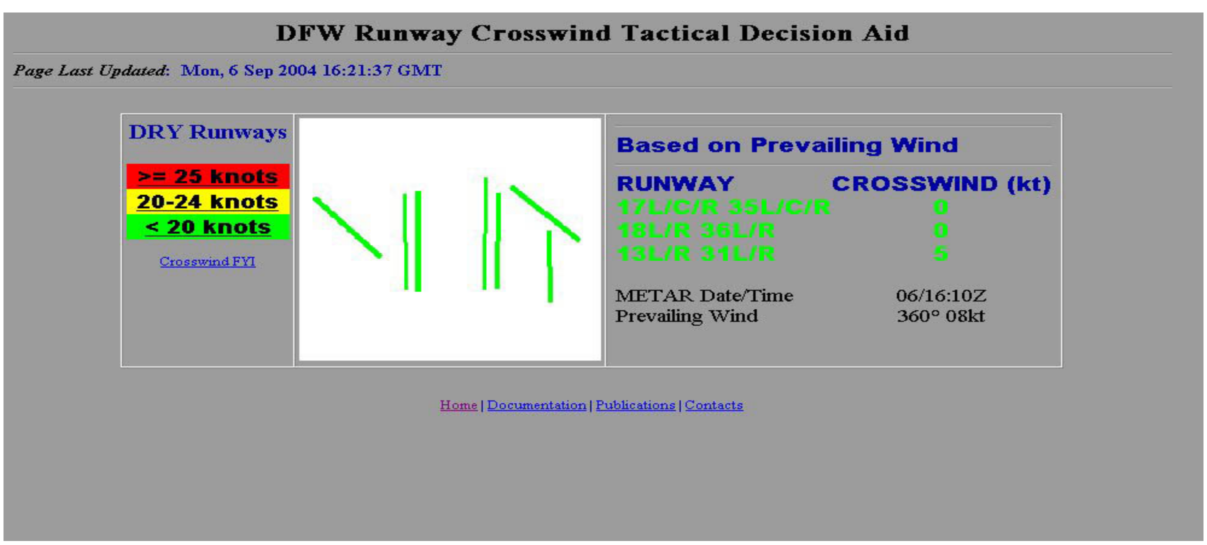

Fig. 3. Crosswind TDA for DFW (Courtesy of Thomas Amis, MIC ZFW).

Technology has provided the aviation weather community an opportunity to shift traditional paradigms and make aviation meteorology support more effective. As the Atlanta holding case study has shown, major airports operating at or above maximum capacity are holding more and more aircraft due to traditionally acceptable weather conditions. When the skies become too congested, safety becomes in jeopardy. It is time that the en route meteorologist at the CWSU's exploit these unique meteorological parameters and equipment, which will ensure a more efficient and safer operation of an ever increasing national airspace.

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