Service Analysis for Weather Information

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Friends and Partners in Aviation Weather (FPAW)
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Outline

• Weather Service Analysis Research Road Map

• Weather Service Analysis - Haze

• Weather Service Analysis – Terminal Convection Time Of Wind Return (TOWR)

• Summary
Weather Service Analysis Research Road Map

Historical Assessment of Phenomena

Preliminary Operational Impact Analysis

Technical Feasibility Research
  Initial Analysis

Technical Feasibility Research
  Expanded Analysis

Operational Impact & Potential Benefits Quantification

Final Concept Development and Requirements

Service Analysis Research “Gate”
(Project Evaluation Stage)
Haze Service Analysis Background

- Visibility through a haze layer – especially at shallow angles (slant range), often reduces normal visibility (7-10SM) to less than 3SM.
- Aircrafts penetrating through this layer would have difficulty seeing the runway or the airplane in front of them resulting in an Instrument Landing System (ILS) approach.
  - Aircrafts must increase spacing from ~3M to 4-6M for IFR conditions *(JO 7110.65T, Section 5-5-4)*
  - Resulting separation reduces capacity and may impact NAS operations
  - Airports with E/W runway configurations are more susceptible due to sun angle refraction, however this is not always the case (CLT as example for final approach turns)
Haze Service Analysis Results

Haze is a frequently occurring phenomena at many Core NAS airports

Several airports issue TMIls for haze, but often due to haze aloft (not at surface - difficult to observe); Other airports (LAX) can often handle haze-related capacity constraint

Summary of Service Analysis Results

- Surface haze is frequent weather phenomena at many core airports - but most manage capacity constraint with minor impacts
- At airports where haze impacts more significant (e.g., EWR), concern is “haze aloft” – difficult to observe and predict
- Haze impacts at ATL (airport where users noted “haze issues”) currently masked by schedule / operations changes
- Haze Service Analysis – halted and tabled after Phase 1 - Phase 1 report documents all haze service analysis findings

Previously significant haze impact at ATL “vanished” in 2010 (TBFM / TMA changes, airline schedule “de-peak”)
**TOWR: Time Of Wind Return in Airport Terminals**

- Critical need to know when synoptic wind regime will become re-established (“return”) after transient, storm-induced wind-shift subsides
  - Need for proactive surface management often highest during these impact events
  - One of today’s solution: Asking nearby Towers “Have your winds returned yet?”

**Synoptic Wind Direction**

- Storm Impact – Winds Shift
  - Enhanced surface management flexibility
  - Reduced taxi time and fuel burn;
  - Increased airport throughput (capacity)
  - Reduced terminal congestion/complexity
  - Increased safety

**Preferred Configuration**

- 22L, 32L

**Reconfigure to Non-Preferred**

- 4L, 32R

**When Will Wind Return?**

**When to Reconfigure to Preferred?**
TOWR Events at Core-29 Airports (2002-2011)

<table>
<thead>
<tr>
<th>Airport</th>
<th>TS with W with TOWR</th>
<th>TOWR</th>
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Time Of Wind Return (TOWR) – 2002-2011

- Moderate similarity in TOWR length among airports in each region
  - JFK, IAH, TPA interesting outliers

- Separating TOWR that occurs with / without ongoing airport convection isolates “operational opportunities” and increases value of results
TOWR Taxi-Out Impacts, Potential Benefits Pool  
(NYC/BOS & DC/PHL Example)

- Largest WS and TOWR impacts associated with convection at New York airports
  - Mostly between 9-15Z, extending most of the day at JFK
  - Occurs during peak departure demand period
- TOWR (‘back-end’) impacts greater than WS (‘front end’) impacts at one point during the day at most Northeast airports
  - Between 9-15 Z at majority of airports, also during peak departure demand time
  - Between 00-03Z at BWI
## TOWR ‘Back-End Impact’ Potential Improvement

- Airports ranked by combined TOWR event frequency and “size” of taxi-out impact
  - Does not take into account other potential impacts / potential benefits associated with runway reconfigurations, taxi-in times and arrival operations, etc.
  - Includes both avoidable and unavoidable impact, so only ROM estimate for potential improvement

- Rankings change when individual components combined
  - Florida airports have top 4 most TOWR events annually, rank low for TOWR taxi-out impacts per aircraft

- Airports ranking highest for annual TOWR impact: ORD, PHL, JFK, IAH, DCA

<table>
<thead>
<tr>
<th>Annual Average TOWR Events (A)</th>
<th>FLL</th>
<th>MCO</th>
<th>MIA</th>
<th>TPA</th>
<th>DFW</th>
<th>MEM</th>
<th>IAH</th>
<th>MDW</th>
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<td>6</td>
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</tr>
</tbody>
</table>

| Avg. TOWR Taxi-Out Impact per Aircraft (B) | 4   | 4   | 3   | 3   | 8   | 2   | 9   | 7   | 12  | 6   | 6   | 12  | 9   | 6   | 9   | 7   | 5   | 2   | 6   | 4   | 22  | 11  | 8   |

| Annual TOWR Taxi-Out Impact per Aircraft (C = A x B) | 132 | 124 | 78  | 72  | 120 | 38  | 162 | 192 | 90  | 72  | 180 | 162 | 84  | 99  | 140 | 60  | 22  | 96  | 40  | 176 | 132 | 48  |

| Annual TOWR Event Rank (A) | 1   | 2   | 3   | 4   | 12  | 6   | 7   | 9   | 10  | 13  | 16  | 13  | 8   | 15  | 20  | 5   | 16  | 19  | 11  | 21  | 22  | 18  | 23  |

| Avg. TOWR Taxi-Out Impact per Aircraft Rank (B) | 17  | 18  | 20  | 21  | 8   | 22  | 6   | 11  | 2   | 13  | 14  | 3   | 7   | 15  | 5   | 10  | 16  | 23  | 12  | 19  | 1   | 4   | 9   |

| Annual TOWR Taxi-Out Impact Rank (C) | 7   | 9   | 16  | 17  | 10  | 22  | 4   | 11  | 1   | 14  | 17  | 2   | 4   | 15  | 12  | 6   | 19  | 23  | 13  | 21  | 3   | 7   | 20  |
TOWR Event Classification Tree Diagram

Seeking Operationally-Relevant TOWR Predictions

Dataset – All terminal convective events

TOWR Event

NO TOWR Event

Storms will prevent TOWR opportunities; Set runways and stage for storm end

No Storms on Runways at TOWR

TOWR will be storm-free; Proactive rwy / surface mgmt opportunities

No runways reconfig; Stage surface & plan arrivals accordingly

Long TOWR (> 2 hr)

Short TOWR (< 1 hr)

Storms on Runways at TOWR

Coordinate and Plan for Multiple Wind Shifts (Runways, Surface, Arrivals)

Plan multiple rwy reconfigs; Target decision points for taxi queues, holding stacks

Plan for extended terminal ops in wind-shift environment (rwys, surface, final approach)

Stage surface & manage arrivals for TOWR conditions soon after rwy storms clear

Stage surface & manage arrivals for “original” conditions soon after rwy storms clear

Long + (Storm End to TOWR)

Short + (Storm End to TOWR)

Long + (Storm End to TOWR)

Short + (Storm End to TOWR)

Long - (TOWR to Storm End)

Short - (TOWR to Storm End)

Storm impact short & “original” wind conditions once done; prepare for minimal disruption

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Preliminary TOWR Event Classification Scheme: ATL *(Precursor to Predictor)*

ATL TOWR Event

No Storms on Runways at TOWR

- Absolute Wind Shift (80-100°)
- Storm Intensity (Level 3-5)

- Long TOWR (> 2 hr)
- Short TOWR (< 1 hr)

- Synoptic Wind Direction

- Not Enough Data

Storms on Runways at TOWR

- Absolute Wind Shift (50-60°)
- Storm Intensity (Level 6)

- Wind Shift (-90 to -120°)
- Storm Intensity (Level 6)
- Distance to Storm (<= 5 mi)
- Synoptic Speed+Gust (0-4 kts)

- Wind Shift (60-90°)
- Storm Intensity (<= Level 5)
- Distance to Storm (5-50 mi)
- Synoptic Speed+Gust (16-24 kts)

- Long △ + (Storm End to TOWR)
- Short △ + (Storm End to TOWR)
- Long △ + (Storm End to TOWR)
- Short △ + (Storm End to TOWR)
- Long △ - (TOWR to Storm End)
- Short △ - (TOWR to Storm End)
Summary

- TOWR events pervasive among most Core-29 airports
  - Most wind shift events have an associated wind return across all airports

- Initial analysis of TOWR impacts / benefits pool for departure operations demonstrates need and potential applications of TOWR predictor
  - Largest avg per aircraft TOWR taxi-out delay per day: JFK (22 min)
  - Top-5 airports with highest TOWR annual taxi-out delay benefits pool:
    1. ORD, 2. PHL, 3. JFK, 4. IAH, 5. DCA

- Technically feasible to create preliminary TOWR classification scheme (precursor to TOWR predictor)
  - Event classification tree developed in context of operational needs
  - Statistical model identifies most important classifiers
  - Adding more data to refine thresholds and “touch on all branches of the tree”
  - Examining numerical forecast data, additional sensor data, etc.

- Work continues on developing / testing initial TOWR predictor & evaluating opportunities / benefits for current ops and NextGen OI’s and DSTs under development