ATM/Weather Integration - Weather Event Detection and Advisory (WEDA)

Bob Avjian
Matt Fronzak
Mike Robinson

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Agenda

- What is the Problem?
- What is the WEDA Solution?
- Atlanta Operational Thresholds
- Notional Display Concepts
- NextGen Line-of-Sight
What’s the Problem?

Terminal Weather Forecasts

Source: MIT Lincoln Lab CIWS display [1]

Approach Type?

Visual

Instrument

Low Instrument

Runway Config?

Source: FAA.gov [2], augmented by MITRE

Traffic Demand

Traffic Manager/ Front Line Manager

Airport Arrival and Departure Rates

Capacity Estimates

Meteorologist's Briefings

Weather Radar

Decision

Terminal Weather Observations

Hourly, variable

Source: FAA.gov [2], augmented by MITRE
Addressing the Problem with the ATM-Weather Integration Framework

**WEDA – an example project employing this framework**

Source: MITRE

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**Weather Sources & Data**

- Examples: NWS, NWP, CSS-Wx

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**Decision Support Tools**

**Level 0**
- Not Integrated
  - Displayed independently
  - Cognitive interpretation
  - Manual use & application

**Level 1**
- Minimally Integrated
  - Displayed on the glass
  - Cognitive interpretation
  - Manual use & application
  - Trajectory generation

**Level 2**
- Weather Translation
  - NAS Constraints
  - Threshold Events

**Level 3**
- ATM Impact Conversion
  - NAS Impacts
  - State Changes

**Level 4**
- Impact Resolution
  - Non wx factors
  - Non wx factors
  - Tactical TFM Solutions
  - Strategic TFM Solutions
  - Optimization

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**Raw weather direct to FAA and User DSTs**
- (E.g., winds and temps for trajectory calculations)

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**Examples:**
- Raw WX factors
  - WARP BT
  - ITWS
  - IDS
  - CIWS
  - AWD

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**Examples:**
- NWS
- NWP
- CSS-Wx

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**Examples:**
- ERAM
- ATOP
- STARS
- TBFM
- TFMS
- Etc.

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**Examples:**
- TBFM Task N
- SFMA
- WEDA

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What is WEDA

…as applied to airport operating state

- Translates raw ceiling, visibility and winds data into airport/terminal operational terms such as runway and/or approach configuration
- An automated capability that detects when current or predicted changes in cloud heights, visibility, wind speed and direction cross, or are expected to cross, site-adapted threshold values ➔ weather event
- Upon detecting a weather event, WEDA
  - sends an advisory to downstream decision support tools
  - provides a depiction of observed and predicted weather events translated to airport operational state on an appropriate NextGen display system

Source: MITRE
KATL – Airport Layout

Source: FAA.gov [2], augmented by MITRE
ATL Approach Types and Weather Thresholds (1/2)

Approach types (V,I): read left to right correlating to ATL North, Middle, South runways (N M S)

- **Visual Approaches (VVV):** Pilot must see aircraft ahead on other approaches or the airport itself

- **Cloud Base < ~ 6000 MSL:** Visual / Instrument / Visual (VIV)

- **Cloud Base < ~ 5000 MSL:** I I V

- **Cloud Base < ~ 4000 MSL:** I I I
  Triple Instrument Approaches

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KATL Airport Elevation ~ 1000 ft

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ATL Approach Types and Weather Thresholds (2/2)

- **Below 1000-3 AGL**
  - 2 nmi increasing to 3 nmi for departure –to- arrivals separation

- **Below 800-2 AGL**
  - Must protect ILS critical areas (around glide slope, localizer antennas)

- **Below 400 ft AGL**
  - Minimum Radar Separation (MRS) is 3.0 nmi

- **Below 200-1/2**
  - CAT II/III operations
### ATL Weather Thresholds Matrix – Triple Arrival Runway Configuration

<table>
<thead>
<tr>
<th>Clouds (h) AGL</th>
<th>Visibility (v)</th>
<th>Airport-Runway-Configuration</th>
<th>Arrival-Procedure-Name</th>
<th>Procedure-Description</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>h &gt; 6000 MSL (5000 AGL)</td>
<td>v &gt; 5 Sm</td>
<td>East (L)</td>
<td>Visual Approach Procedures (VAPS)</td>
<td>Visual Approach Procedures (VAPS) to 8K and 10K</td>
<td><strong>Clouds above normal turn-on altitudes for runways 8L/26R (5000 MSL), 9R/27L (5000 MSL), and 10R/28L (4000 MSL)</strong>&lt;br&gt;<strong>AAAR 132F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
</tr>
<tr>
<td>5000-MSL (4000 AGL)</td>
<td>v &gt; 5 Sm</td>
<td>East (L)</td>
<td>VNAV</td>
<td>Visual Approach Procedures (VAPS) to 8K and 10K</td>
<td><strong>Clouds at or below normal turn-on altitude for runways 8R/26L (5000 MSL) and 9R/27L (5000 MSL), but above-normal-turn-on altitude for runways 8L/26R (5000 MSL) and 10R/28L (4000 MSL)</strong>&lt;br&gt;<strong>AAAR 114F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
</tr>
<tr>
<td>4000-MSL (3000 AGL)</td>
<td>v &gt; 5 Sm</td>
<td>East (L)</td>
<td>ILS</td>
<td>Instrument Approach Procedures (IAPS) to 8K and 10K</td>
<td><strong>Clouds at or below normal turn-on altitude for runways 8R/26L (5000 MSL) and 9R/27L (5000 MSL), but above-normal-turn-on altitude (4000 MSL) for runway 10R/28L</strong>&lt;br&gt;<strong>AAAR 114F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
</tr>
<tr>
<td>1000-MSL (5000 AGL)</td>
<td>3.5M ≤ v ≤ 5 Sm</td>
<td>East (L)</td>
<td>Instrument Approach Procedures (IAPS) to 8K and 10K</td>
<td><strong>Clouds below normal turn-on altitudes for all three arrival runways and visibility below that required for visual separation</strong>&lt;br&gt;<strong>AAAR 114F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
<td></td>
</tr>
<tr>
<td>1000-MSL (5000 AGL)</td>
<td>3.5M ≤ v ≤ 5 Sm</td>
<td>West (L)</td>
<td>Instrument Approach Procedures (IAPS) to 8K and 10K</td>
<td><strong>Clouds below normal turn-on altitudes for all three arrival runways and visibility below that required for visual separation</strong>&lt;br&gt;<strong>AAAR 114F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
<td></td>
</tr>
<tr>
<td>400 AGL</td>
<td>1.5M ≤ v ≤ 5 Sm</td>
<td>East (L)</td>
<td>ILS</td>
<td>Instrument Approach Procedures (IAPS) to 8K and 10K</td>
<td><strong>Clouds below normal turn-on altitudes for all three arrival runways and visibility below that required for visual separation</strong>&lt;br&gt;<strong>AAAR 114F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
</tr>
<tr>
<td>200 AGL</td>
<td>1.5M or RVR 1800 FT ≤ v ≤ 1.5M</td>
<td>East (L)</td>
<td>ILS</td>
<td>Instrument Approach Procedures (IAPS) to 8K and 10K</td>
<td><strong>Clouds below normal turn-on altitudes for all three arrival runways and visibility below that required for visual separation</strong>&lt;br&gt;<strong>AAAR 114F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
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<tr>
<td>h &lt; 200 AGL</td>
<td>v ≤ 1.5M or RVR 1800 FT</td>
<td>East (L)</td>
<td>CAT-I, II or III-Low-Approach Procedure (IAPS) to 8K and 10K</td>
<td><strong>Clouds below normal turn-on altitudes for all three arrival runways and visibility below that required for visual separation</strong>&lt;br&gt;<strong>AAAR 114F</strong>&lt;br&gt;<strong>Maximum tailwind component 5-7 KTS per FAA Order 8400.9K</strong></td>
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1 Normal cloud heights, visibilities, tailwinds and altitudes are values used by traffic managers to achieve an acceptable level of operational consistency and minimize procedural and clearance changes and controller time on frequency while simultaneously maximizing airport arrival tare (capacity)
2 Procedural cloud heights, visibilities, tailwinds and altitudes are values consistent with FAA Orders, facility standard operating procedures (SOPs) and regulatory limitations
3 Cloud heights are expressed in feet and are indicated if referenced to mean sea level (MSL) or above ground level (AGL).
4 Altitudes expressed in height above mean sea level (MSL) are equivalent to height above ground level (AGL) + mean field elevation (~1,000 FT for KATL).
Airport icons below represent the METAR-based C&V state for each ASOS/AWOS site within 80 nmi of ATL. The colors will be according to the WEDA logic table on next slide.

Circle symbols for METAR data
Square symbols for TAF data

Range Rings correspond to target rings at 5, 20, 40, 60 nmi about ATL airport center
Blue lines are True N/S, E/W oriented

Hovering on airport icon brings up the details box. Source of data for current and past time are METARs and for future time, are TAFs

Source: MITRE
A decision on the approach and runway configuration, airport arrival rate (AAR) and airport departure rate (ADR) is based on a combination of weather data, operational doctrine, ATC terminal operations and local knowledge.

WEDA contributes one set of weather factors to the decision thread.
Backup
WEDA Project Research Objectives

- **Initial Concept Development focusing on Airport Operating State**
  - Identify key weather thresholds pertinent to airport operating state

- **Identify weather events, forecast uncertainties and advisories**
  - Deliverable: Annotated briefing – “Concept Validation Results – Initial Report” [Dec 16, 2016]
  - Deliverable: Initial WEDA Demonstration Capability [April 30, 2017]

- **Evolve the WEDA operational concept through tabletop and field evaluations**

Research sponsored by FAA’s Advanced Concepts & Technology Development Office – NextGen Aviation Weather Division (ANG-C6)
Next Steps

**WEDA Demonstration Capability (WDC)**

Web-based application that ingests and processes live weather observation and forecast data to explore ways to display weather event and threshold information and exploring the relationships between weather forecast uncertainties, alert parameters and operational risk management.

**KATL/A80 Field Evaluation**

Active operational users from KATL and A80 TRACON evaluate WEDA operational concept using the WEDA Demonstration Capability.

- **WEDA evaluation exercises at KATL and A80 using WEDA Demonstration Capability – February/March 2017**
- **WEDA Operational Concept Description Update – April 2017**

**Update Operational Concept Description**

Evaluation exercises inform the evolution of the WEDA Operational Concept Description.
Related Prior Work – Example CWSU Tactical Decision Aids

Terminal Aerodrome Forecast-based Tactical Decision Aid
Impacts TAF Board
Source: NWS https://www.aviationweather.gov/taf/board

MIT Lincoln Lab Experimental Terminal Ceiling & Visibility Product
2006 AMS Conference
Source: ams.confex.com/ams/Annual2006/techprogram/paper_103710.htm

CWSU-based Thunderstorm Tactical Decision Aid
Source: NWS CWSU Various Tactical Decision Aids (winds, icing, convection, etc.) http://www.weather.gov/ztl/

AWC Gate Forecast Product
Source: NWS
https://www.aviationweather.gov/trafficflow/gmt/gate
“Observations Lead the Way”

1. Observations (or networks) that are needed to benefit your future research, application or product development
   - Denser network of approved weather stations (e.g., AWOS/ASOS) within 60-80 nm of major airports with 1 min or 5 min rather than 15 min updates available for wide area dissemination
   - Additional network bandwidth will be needed to accommodate the increased attendant demand

2. Recommended instruments that are needed to make these observations
   - Generally, improved sensor accuracies and rapid updates (e.g., OMO) widely disseminated….which will require additional attendant network bandwidth
# References

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