

## Friends & Partners in Aviation Weather Spring 2022 Meeting

## **NextGen Weather – Past**

"Those who cannot remember the past are condemned to repeat it." (George Santayana, 1905)

#### **Presenters/Panelists**

Jim Evans, Matt Fronzak

#### **Contributors/Panelists**

Bruce Carmichael, Rick Heuwinkel, Kevin Johnston, Bill Leber, Phil Smith, Gene Wilhelm

## Key NextGen Weather Components



The following are some of the key features associated with NextGen Weather during its now 35+ year development:

- "The inclusion of weather information into the logic of a decision process or a decision aid such that weather constraints are taken into account when the decision is made or recommended; the goal of weather integration is to minimize the need for humans to [cognitively] gauge NAS weather constraints and to [cognitively] determine the optimum mitigation of these constraints."<sup>1</sup>: ATM-Weather Integration
- A modern source of weather information: **4D** Weather Cube
- Common weather information used for collaborative decision making: Single Authoritative Source

## Of those three, **ATM-Weather Integration** was considered by many to be the most important.

<sup>1</sup> Joint Planning and Development Office (JPDO), Next Generation Air Transportation System (NextGen) ATM-Weather Integration Plan Version 2.0, September 24, 2010

## Weather ATM Integration Working Group (WAIWG) – What and When



#### <u>What</u>

A working group of the NAS Operations (NAS Ops) Subgroup of the FAA Research, Engineering and Development Advisory Committee (REDAC)

#### <u>When</u>

Formed in Fall 2006; given 12 months to do its work and report out; disbanded after delivering its final report in October 2007

## Weather ATM Integration Working Group (WAIWG)



#### <u>Who</u>

Chairman <mark>Bill Leber</mark> (Northwest Airlines), Co-Chairman Ray LaFrey (MIT LL retired), DFOs John Rekstad and Rick Heuwinkel (FAA), Roger Beatty\* (American Airlines), Steve Brown (NBAA), Bruce Carmichael (NCAR), Jim Evans (MIT LL), Dave Frame (JTA), Matt Fronzak (Delta Air Lines), Steve Green (NASA Ames), Kevin Johnston (NOAA NWS), John McCarthy (NCAR retired), Phil Smith (The Ohio State University), Gene Wilhelm (MITRE CAASD)

#### <u>Product</u>

Report of the Weather-ATM Integration Working Group (<u>https://www.faa.gov/about/office\_org/headquarters\_offices/ang/redac/media/reports/Report-WeatherWorkingGroup.pdf</u>)

## Key WAIWG Overarching and Near-Term Research Recommendations



#### **Overarching Recommendations**

- Establish Senior Leadership oversight and REDAC monitoring
- Develop AWRP requirements to support integration efforts

#### **Research Recommendations: Near Term - IOC 2010**

- Translate convective weather into ATC impacts
- Improve AFP by developing a 6- to 10-hour weather impacts forecast
- Improve weather input into Collaborative Traffic Flow Management
- Integrate airport and terminal area automation with weather

## Key WAIWG Mid- and Far-Term Research Recommendations



#### **Research Recommendations: Mid Term - IOC 2015**

- Develop adaptive integrated ATM procedures for incremental route planning
- Develop adaptive integrated ATM procedures for tactical trajectories
- Develop flexible airspace for weather impacts as a fundamental and initial ATM design requirement

#### **Research Recommendations: Far Term - IOC Post 2015**

- Replace surrogate weather indicators with true measures of flight hazards
- Conduct research on probabilistic and deterministic forecasts for multiple dynamic flight lanes
- Conduct research on gridded and scenario-based probabilistic weather data for ATM decision tools

## Key WAIWG Human Factors, Enterprise Architecture and AWRP Recommendations

#### **Human Factors**

- Conduct research on the human factors aspects of ATM-Weather Integration
- Identify best weather practices of air traffic facilities and train these practices system wide

#### FAA and NextGen Enterprise Architectures

 Ensure that direct ATM automation-weather integration is a key focus of the development of OEP/NAS Enterprise Architecture operational and technical views for the transition to NextGen

#### **Aviation Weather Research Program**

• Increase support to enable participation in joint ATM-Weather Integration research











## The Ketchup (Catsup?) Mustard Chart V1



A big shout out to MITRE colleagues Gene Wilhelm, Mark Huberdeau and Claudia McKnight for their significant contributions to the KM Chart!

## Levels of ATM-Weather Integration





How can we classify the different levels of ATM-Weather Integration achieved by FAA systems?



## The Ketchup (Catsup?) Mustard Chart V1+



Props to MITRE colleague Bob Avjian for inputs to this version of the KM Chart!



### How has ATM-Weather Integration Worked Out in Practice?



- Some successes (TDWR, ITWS, CIWS, CWAM)
- Many current problems with the advanced weather-ATM systems
  - Production RAPT installed at NY, ORD, PHL, DC but current operational benefits unclear
  - SFO marine stratus dissipation decision support is facing many challenges to forecast system operation; the GDP planning backend (GPSM) was turned off in 2013 due to lack of support
  - Arriving at deterministic flow decisions (e.g., GDP and AFP parameters given a probabilistic forecast of flow rates) has been a major challenge
- Institutional (NWS, FAA) problems dealing with R & D responsibility (e.g., "is it weather or TFM", training that considers operational usage, and updating system (with user engagement) as weather and ATM changes occur
- Developing and validating ATM models for airspace usage in convective weather (e.g., Traffic Flow Index [TFI] for AFP decision support) has proven a difficult challenge

ARAM Evans- 12 ATM-wx



# Why the Differences in Current Operational Effectiveness of RAPT versus CIWS?



Factor	CIWS	RAPT Prototypes	RAPT Production
Tailored to Generic Decision Making	Yes	NA	NA
Develop ATM model for specific facility decisions	No	NY, ORD-partial	NY, ORD-partial, PHL, PCT-no
Training in use of display	Yes	Yes	Yes
Annual facility specific scenario training	Yes	Yes	No
Full complement of product reliability information	Yes	Yes	No
Post event online archive	Yes	Yes	No
Operational use metrics to drive training and refinement	Only initially	Yes	No
Airline real time access	Yes	Yes	Limited
Airline access to post event archive and, annual training	Yes	Yes	No





- Improving coupling to the key operational decision makers
  - Highly successful developments had close coupling to the operational decision makers over several years using prototypes
  - Arriving at adequate ATM models critical for highly integrated systems
- Handling weather forecast uncertainty and complicated (e.g., AI) algorithms
  - A major problem for convective weather ATM for the foreseeable future need to understand and address risks for operational decision makers
  - The success of CWSU located within the TMU at ZTL in helping ATC make ATM decisions suggests providing a tailored parallel weather/ATM information stream to CWSU staff located in the TMU area
- Training driven by post event assessment of operational decisions
  - FAA PERTI (Plan, Execute, Review, Train, Improve) opportunities exist to become more effective
- Improve management for ATM-weather decision system R & D, ongoing maintenance/refinement <u>and</u> operational usage driven training



# Panel and Audience Discussion

## Q1 – How Have We Done at AWI?



• Not so well

## Q2 – Why?



- Failed to create operational traction
- May not understand the concerns and needs of potential users
- Unable to convince the users of the benefit
- Concepts don't excite those who control budgets
- FAA Air Traffic has no interest in moving in this direction
- Automated solutions viewed as a threat (e.g., GPSM and the blow-back from the TMs thinking they would lose their jobs)
- More objective use and evaluation of weather will expose the warts and inconsistencies in TFM decisions
- Inherent negative views about the use of weather in more proactive decision making
- Need for cross-organizational, multi-LOB FAA funding and involvement

## Q3 – Where Are We?



• Not very far

# Q4 – How Can We Make ATM-Weather Integration Progress?



- Paraphrasing V. Ballentine (UK Met) in the paper on *The use of marketing principles* to maximize economic benefits of weather, "It has been said that ATM-weather integration only has benefit, positive or negative, if it changes a decision"
- Hence, let us ask for which current decisions is it clear that feasible ATM-weather integration (i.e., impact identification and resolution) could change and lead to better operational outcomes?
  - Past examples of identified opportunities for improved decision making
    - GPSM A probabilistic forecast (MSFS) without explicit guidance for GDP parameters had yielded little if any reduction in avoidable delay due to marine stratus impacts on SFO
    - RAPT Use of pathfinders to reopen departure routes when convective impacts ended caused excessive avoidable departure delay
    - DRAW (Dynamic Routes for Arrivals in Weather) Enabled AA dispatch to determine and propose to the FAA more efficient alternative departure paths at DFW for AA aircraft when convection impacted the normal DFW departure routes and, the FAA did not have time to develop plane specific better routes
- What are the additional factors that need to be considered in opportunity identification?
  - How much uncertainty exists in forecasts?
  - Can meaningful risk management decision support be provided?
  - Is translation to "capacity" straightforward ?



# Summary and Recommendations

## Summary



- A lot of blood, sweat and tears went into defining and promoting the most critical NextGen Weather capability, ATM-Weather Integration (AWI), in the early 2000's, culminating in its inclusion in both the Report of the WAIWG in 2007 and the JPDO ATM-Weather Integration Plans later that decade
- Unfortunately, there have been few successful AWI capabilities fielded at the FAA, and the highest level (Level 4) AWI tool, the SFO Ground Delay Program (GDP) Parameters Selection Module (GPSM), was ultimately abandoned due to lack of user and fiscal support

## Recommendation



• FPAW should write a white paper urging the FAA to review and revive its commitment to ATM-Weather Integration, to include supporting relevant research projects that are funded by both FAA Met and ATC/TFM lines of business and and involve participation of both Met and ATC/TFM users and researchers

## Backup Slides

## Deep NextGen Weather History



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#### 20 Years Ago: Next Generation Air Transportation System Aviation Weather Forecasting Task Force

- FAA Funded
- Originally looked out 15 years from 1986 (to 2001)
- Membership:
  - John McCarthy, Chair (NCAR)
  - Stan Benjamin, NOAA
  - Jim Dziuk, FAA
  - Bill Hooke, NOAA
  - Sandy MacDonald, NOAA
  - Bob Maddox, NOAA
  - Ron McPherson, NMC
  - Ralph Petersen, NASA
  - · Wayne Sand, Univ. of Wyoming
  - Bob Serafin, NCAR
  - Dick Taylor, Ohio State Univ.
  - Rich Wagoner, NOAA

## Deep NextGen Weather History



Five ATM-Weather Integration Workshops were held to encourage better use of aviation weather in air traffic management:

- Workshop #1 May 2000
- Workshop #2 July 2002
- Workshop #3 January 2003
- Workshop #4 June 2003
- Workshop #5 October 2004