#### **NAS Ops Subcommittee Review**

#### Weather Technology in the Cockpit (WTIC) – Project Updates and Review of FY21 Proposed Portfolio A12.c

By: Gary Pokodner, WTIC Program Manager Date: September 5, 2018



# Weather Technology in the Cockpit (WTIC) - Program Description

- Research projects to develop, verify, and validate recommendations for incorporation into Minimum Weather Service (MinWxSvc) standards/guidance
  - FAR Part 121, <u>OPERATING REQUIREMENTS: DOMESTIC, FLAG, AND SUPPLEMENTAL</u> <u>OPERATIONS (i.e. commercial operations)</u>
  - FAR Part 135, <u>OPERATING REQUIREMENTS: COMMUTER AND ON DEMAND</u> <u>OPERATIONS AND RULES GOVERNING PERSONS ON BOARD SUCH AIRCRAFT (i.e.</u> <u>commuter, on demand, and air taxi operations)</u>
  - FAR Part 91, <u>GENERAL OPERATING AND FLIGHT RULES</u> (includes General Aviation operations)

#### • The MinWxSvc is defined as:

- Minimum cockpit meteorological (MET) information
- Minimum performance standards (e.g. accuracy) of the MET information
- Minimum information rendering standards
- Enhanced weather training
- Minimum cockpit technology capability recommendations



# **WTIC Program Overview**

#### Purpose

- Identify causal factors for weather-related General Aviation (GA) safety risks/hazards
- Identify causal factors for Part 121/135 adverse weather safety risks/hazards and NAS operational inefficiencies (current and NextGen)
- Recommend MinWxSvc(s) to resolve/reduce identified safety risks and NAS inefficiencies
- Recommend enhancements to pilot MET-training to resolve training shortfalls

Budget	FY18	FY19	FY20
	(funded)	(request)	(request)
	\$2.54M	\$1.027M	\$0.939M



# **WTIC Program Overview**

#### Benefits

- Enhanced safety by resolving/reducing adverse-weather safety risks before they result in an accident/incident
- Enhanced NAS efficiency and increased capacity resulting from consistent and predictable pilot adverse weather decision making due to established cockpit minimum weather service(s)
  - Reduced emissions due to enhanced efficiency
  - Reduction in flight delays
  - Enhanced flight routing in and around adverse weather
- Enhanced safety resulting from the resolution of pilot MET-training shortfalls

#### Tracking

 Developing spreadsheet to track gaps, operational shortfalls, and MinWxSvc(s) recommendations



# Open NAS Ops Recommendations and Action Items

No NAS Ops Open Action Items or Recommendations



### **WTIC Collaboration and Partners**

#### Government

- FAA
  - Flight Standards Service
    - Test questions AFS-630
    - NEXRAD Online Course AFS-850
    - ASRS report AFS-430
  - Aircraft Certification
  - Small Aircraft Directorate
  - Office of Aviation Safety
  - Human Factors Research & Engineering
  - William J. Hughes Technical Center(WJHTC)
  - Civil Aerospace Medical Institute (CAMI)
- NASA
  - Ames and Langley
- NTSB
- NCAR

#### International

Eurocontrol

#### Airlines

- Delta
- United
- American

#### Academia

- Embry-Riddle Aeronautical University
- Florida Institute of Technology
- Georgia Institute of Technology
- Iowa State University
- Purdue University
- Texas A&M University
- The Ohio State University
- University of Oklahoma
- Western Michigan University
- Virginia Tech

#### **Professional Societies**

- AOPA
- GAMA
- RTCA
- SAE
- Others (via GAJSC)
- Royal Aeronautical Society
- NAFI

#### Industry

- Lockheed Martin (via PEGASAS)
- Frasca (via PEGASAS)
- Mindstar Aviation (via PEGASAS)
- Fly8Ma (vis PEGASAS)
- WebManuals (via PEGASAS)
- Foreflight (via AOPA)



- Wind Study Phase 6 and 7: Developed and released RTCA DO-369 Standard on guidance for the usage of data linked wind information. Resolve selected gaps based on review of 4DTBO demonstration and flight demo reports (NASA 19-day test on IM). Began development of research plan to enable strategic versus tactical pilot-originated reroute requests due to adverse winds. Completed Phase 6 final report and Phase 7 kickoff meeting.
- Remote Oceanic Meteorological Information Operational (ROMIO) Demonstration: Completed planning, training, and procedures for performing ROMIO demonstration. Data collection with Delta Airlines is ongoing. Delays with United and American due to non-ROMIO related inflight communications issues, but planning to start by September. The issue is Panasonic Avionics rack testing the ROMIO application to insure it will not interfere with commercial weather product. Initial inputs to benefits analysis being conducted by Virginia Tech on track with no issues.



- Weather Information Latency Demonstrator (WILD): PEGASAS reached an agreement with Mindstar Aviation, a leader in the development of flight simulator software, to incorporate WILD capability into their software which will result in the transition of this capability to over 20 commercial simulators. Completed development of associated manuals, instructions for use, and final configuration. Project completed with transition to operations.
- **Augmented Reality Application:** Developed prototype application for training and reference using augmented reality. Fly8Ma, a company that offers a variety of online pilot training courses, joined as partner to host app and maintain it after initial configuration developed. Application presented at Air Ven

seminars for NAFI. Over 100 pilots/instructors using prote to develop an initial release in FY19.

#### Look for the WeatherXplore



logo. Scan images with the demo app with your phone or tablet to see augmented reality made easy.





- Nulling NEXRAD Latency: A research plan was completed. Algorithms were identified, assessed, and selected to null out NEXRAD latency. Assessment procedure developed including test cases to compare pilot performance and preference of current NEXRAD versus NEXRAD with latency nulled out.
- **RTCA SC-206:** Completed and published DO-370 Guidelines for EDR Algorithm Performance (Dec 2017). On track to complete DO-358A by March 2019 which is an update to the FIS-B UAT MOPS including the six new weather products that were added and brought online at the end of July. Also began updating DO-364, Minimum Aviation System Performance Standards (MASPS) for Aeronautical Information/Meteorological Data Link Services Systems to include EUROCAE harmonization with target completion by Dec 2020.
- **Immersive Training**: Completed immersive training module on Estimating Visibility. Available on multiple websites and can be accessed via augmented reality application. Based on feedback from the National Association of Flight (NAFI) at Air Venture, investigating providing a series of weather courses on the augmented reality application to provide NAFI with a complete weather curriculum. A Latency module is under development and scheduled for completion at the end of September. Additional module development is TBD based on feedback and metrics of the first two modules.



- VFR Not Recommended (VNR) Assessment: Developed plan for experiment, produced eight scenarios, ran experiment, and began data analysis. Preliminary results indicate pilots were more conservative than Flight Service Specialists (FSS). Results indicate lack of process and objective criteria by pilots and FSSs. Consistent decisions/recommendations on "easier" scenarios, but not on marginal scenarios though pilots had better consensus. Assessing options for next phase and path forward.
- Pilot Knowledge Assessment: Completed Phase 2 of knowledge assessment which provided weather test questions to older and more experienced pilots than Phase 1. Results were similar. Final report being completed. Results used in Wings Credit course provided to NAFI during Air Venture. Course was recorded and is online. Results used to highlight areas to focus on when teaching weather and to develop immersive training.
- Crowd Sourcing Visibility Information: Completed analysis of crowd sourcing visibility demonstration with over 80% of the results being comparable to ASOS.
   Developing hybrid solution using AWRP edge detection software to reduce cost in an operational setup. Demo of hybrid completed in August to assess impacts of edge detection software being part of the crowd.



- Slant Ranging Study: Study demonstrated that teaching "slant ranging" to estimate visibility and distance enhanced pilot accuracy by approximately 50%. Technique was provided to NAFI at Air Venture seminars and to pilots at the WTIC booth. Feedback was that it was simple and that most pilots were not taught a method to estimate distance or visibility so they guess. Project complete.
- Forecast Icing Product (FIP) for FIS-B: Study provided inputs for recommendations for displaying Current Icing Product (CIP, Forecast Icing Product (FIP) and Supercooled Large Droplets (SLD) for use in cockpits. Report was well received and is being incorporated by RTCA for standards. Project complete.
- **Dynamic Digital Repository:** Developed initial architecture for a repository of PEGASAS research data, reports, and associated publications, and eventually other WTIC products. An industry partner, WebManuals, has been identified for transition of the repository to implementation and maintenance at no cost due to alignment with their products.
- Voice Recognition: Performed initial assessment of current voice recognition applications/software for use in cockpits for weather applications. Research completed and final recommendations being developed. Potential applications with PIREP modernization study.



- Adverse Weather Notifications: Completed research and developed MinWxSvc recommendations for coded adverse weather notifications to enable pilots to prioritize response. Recommendations to be provided to industry. Project complete.
- **Tactical Turbulence:** Identified and corrected issues with code. Worked on analysis to use TFMData versus ASDI data in determining aircraft position and intent. Continuing tasks to refine predictions of aircraft that will encounter a turbulence event and comparing performance of 0 Minute delay and 5 minute delay TFMData. A technical transfer package will be developed after TFMData analyses and software updates completed.
- **GA Response to Probabilistic Weather Information:** Developed part-task demonstration plan, conducted part-task experiment, and produced a final report that assessed how pilots would use and respond to having a graphical presentation of probabilistic weather in the cockpit. Results indicated that pilots preferred the two forecasting displays used in the experiment more than looping NEXRAD-type display and felt that the forecast displays would keep them safer distances from adverse weather, but there was variability in pilot preferences and opinions.



- Wind Information Using Wind Socks: Completed development of demonstration plan, executed demonstration, and completed final report on producing surface wind information using a single camera and Harris' Helios product. Overall, the demonstration was successful with Helios producing useful wind information and identifying camera constraints for consistent and accurate outputs. Follow-on or MinWxSvc recommendations are still being assessed.
- **Time Stamping MinWxSvc Recommendations:** Completed Phase 2 research and submitted a draft report on the processing of NEXRAD composites and recommendations for time stamping standards to better reflect the average age of the information in the composite. Revisions to the draft report were identified to correct various issues and omissions.
- **Pilot Reports (PIREP) Modernization:** Reviewed AOPA and NTSB report on gaps associated with PIREP generation and submittal. Reviewed numerous PIREP and non-PIREP applications and systems to identify existing technology and capabilities to address the gaps. Prepared "screens" of potential gap resolutions for pilot assessments. Performed assessment at Air Venture with over 100 pilots with diverse backgrounds participating. Results of the assessment are currently under review.



### **Transition to Implementation Accomplished**

WTIC Output/Product	Recipient	How WTIC Output Used
Wind Trade Studies	RTCA S-206, 227, 186 NextGen Operations (AIM, TBO) Industry (FMS manufacturers)	<ol> <li>RTCA Wind Guidance Document (DO-369) July 13, 2017</li> <li>Standards and performance requirements impacted by winds</li> </ol>
MinWxSvc Recommendation Final Reports	RTCA SC-206 FAA Certification	MOPS for FIS-B with UAT (invoked by TSO-157B)
Human Factors Research Papers and Final Reports	SAE	ARP-5740
NEXRAD Scenario-Based Training Module	FAA AFS-850, AVS	Training on FAASTeam Website
Private Pilot written exam weather knowledge test questions	AFS-630	Updated weather knowledge questions on exam and practice questions
General Aviation gap analysis final reports and some initial MinWxSvc recommendations to resolve them	GA Pilot Community (AOPA) Aviation Industry	<ol> <li>Magazine articles including: FAA Safety, AOPA, Avionics News, Managing the Skies,</li> <li>Presentations to pilots and industry</li> </ol>



### **Transition to Implementation Plans**

WTIC Output/Product	Recipient	How WTIC Output Used
Weather Information Latency Trainer (WILD)	FRASCA, Redbird, other simulator manufacturers, AFS- 600, Mindstar Aviation	Incorporate WILD capabilities into commercial trainers and simulators
WILD Training Curriculum	Schools, FAASTeam Website	Provide training on weather latency with or without a WILD or WILD capability
Psychometrics of test questions	Flight Standards (AFS-630)	Identify level of pilot weather knowledge to be tested
Augmented Reality Application	Fly8Ma	Application will be used for training and as a weather reference tool. Prototype available in Google and Apple stores. Fly8Ma to maintain application currency.
Immersive Training Modules	Pilot Community, NAFI, and FAA training website	By pilots and flight instructors as training on weather.



### **Transition to Implementation Plans**

WTIC Output/Product	Recipient	How WTIC Output Used
Crowd Sourced Visibility Information (Potentially Wind Also)	FAA Alaska Webcam Site (Prototype site first) National Weather Service (based on information quality)	Populate visibility and wind fields in new Weather InSight configuration
Tactical Turbulence Notification MinWxSvc Recommendation	FAA Flight Standards Airlines Industry	Weather product application and/or standard defining performance
Mobile MET MinWxSvc Recommendations	Industry Pilots	<ol> <li>Provide Mobile app developers recommendations to support pilot decision making.</li> <li>Educate pilots on app features to look for.</li> </ol>
Cloud Top Heights and Convective Oceanic Diagnostic	FAA Flight Standards, Airlines	Enhanced decision making an efficiency in oceanic regions with respect to convection
Eddy Dissipation Rate (EDR) Uplink and Technical Transfer Package	Delta Airlines, Boeing, Communications Providers	<ol> <li>Delta pilots using EDR viewer</li> <li>Boeing selling EDR as option in ACMS package (sold to United already)</li> </ol>



#### PROFICIENCY: INTO THE WILD PILOTS GET WAKE-UP CALL ABOUT WEATHER

#### By David Hughes

Having datalinked in-flight weather information is a major safety advancement, assuming it's utilized correctly. Outdated or unnoticed weather information can lead to accidents. To help general aviation pilots understand how easy it is to misinterpret weather information displayed in the cockpit. FAA researchers developed a simulation that demonstrates some of the most dangerous pitfalls.

## **Transition via Outreach**

#### Weather Forecasting Deserves Some Credit For **Eve-Popping Aviation Safety Headlines**

Under funding from the Federal Aviation Administration's Aviation Weather Research Program and Weather Technology in the Cockpit Program, an automated in situ turbulence reporting capability was developed at NCAR that allows for more accurate and timely information on turbulence experienced by aircraft in flight. The Eddy Dissipation Rate (EDR) algorithm uses data from aircraft

#### Participate in Cockpit Weather Display Training at AirVenture



•The FAA has begun research to help answer that question and measure the present effectiveness of "VFR not recommended." The agency's Weather Technology in the Cockpit (WTIC) program has made this research a priority as the FAA prepares to award its Future Flight Service Program contract in 2018. AOPA believes that making a decision about the usefulness of "VFR not recommended" should be a top-priority task for the FAA's flight service.

#### Avionics and Air Traffic Seminars and Events

There are several avionics-focused trainings, events and panel discussions occurring next at AirVenture this year. Here are some of that you may find interesting.

#### Cockpit Weather Display Training

An ongoing feature at AirVenture will be "The Partnership for the Enhancement of GA Safety, Accessibility, and Sustainability (PEGASAS) Weather Information Latency Demonstrator (WILD)" located in the Pilot Proficiency Center. The project is one of 20 under the PEGASAS umbrella and aims to address the number of weather-related accidents in general aviation, 80% of which are fatal, according to EAA.

Pilots will be able to fly the WILD simulator, which provides a demonstration of how information on some of the most common cockpit weather displays are delayed in comparison to actual airspace conditions. The FAA is looking to use the findings of the PEGASAS "Weather Technology in the Cockpit (WTIC) project" to define minimum weather service standards and developing educational and technological solutions that will help improve safety for general aviation pilots





that may prevent visual flight conditions. The goal is to make VNR more objective, description

## **Anticipated Research in FY19 and FY20**

- Planned Research Areas Based on Current Reduced Funding Estimates
- Anticipate less projects per FY and less scope per project
  - Develop resolutions to identified gaps on helicopter operations in adverse weather conditions including military, emergency medical, oil rigs, and tourist. Gap analysis funded with FY18 funds, but conduct in FY19.
  - Refine prototype augmented reality application and transition to operations vis Fly8Ma
  - Release of Version 1 set of Minimum Weather Service recommendations (culmination of ongoing/previous GA rendering work and recommendations)
  - Prototype modernized PIREP concept based on FY18 research results and perform evaluation
  - RTCA SC-206



# Anticipated Research in FY19 and FY20 (cont)

- Identification of en-route objective criteria for adverse weather for use in determining aircraft intent versus ability to meet an Required Time of Arrival (RTA). FY20, still obtaining details on Trajectory Based Operations (TBO) concepts of intent versus hard RTAs.
- Phase 2 of VNR research develop recommendations for objective criteria and process to assess VNR/VFR conditions
- Continue research on impacts of winds on NextGen operations including strategic RTAs to support Trajectory Based Operations (TBO). Develop and formalize lexicon of wind related terminology such as, "ATC Winds."
- Part 135/91 assessment of MRMS versus NEXRAD including use of adapted EDR viewer for altitude display of icing information





## **Emerging FY21 Focal Areas**

- Phase 3 research to develop and verify objective criteria for VNR issuance
- Follow on research on using graphical presentations of probabilistic weather in the cockpit
- Continue development of resolutions to identified gaps on helicopter operations in adverse weather conditions including military, emergency medical, oil rigs, and tourist.
- Gap analysis of special GA operations (non-helicopter)
- Explore options for providing weather avoidance guidance versus weather information
- Follow-on phases to FY19 and FY20 research projects



# BACKUP



### **ROMIO Feedback Example**

- FEEDBACK EXAMPLE: Just wanted to pass along a couple of quick observations. I did fill out the survey for VT. I flew two transcons midweek, with a fair amount of convective activity. It was an excellent opportunity to compare ROMIO/Weather Viewer/Radar. While ROMIO is envisioned as more of an Oceanic tool, it definitely has efficacy in the Heartland. The CTO is spot on, and the CDO is accurate, but the lateral confines of the depicted area seem to be too large. We had the luxury of daytime flying, with many large, independent cells. We also had areas with a line of weather, and blowoff from the tops. We played the game by asking: "if it was nighttime and we only had ship's radar, how far would we deviate?" ROMIO indicates a broader dispersion than was indicated by radar, or referenced visually. Conversely, the "playback" feature is a great tool, showing whether the convective activity is maturing, or declining. The Weather Viewer was a nice mixture, with the "cloud coverage" feature actually providing a pretty accurate tool for activity. Collectively, all 3 gave us a real time, accurate planning tool for deviation.
- As I mentioned, ROMIO alone would probably induce a wider deviation than might be necessary. I leave Friday for a 12 day Asia trip, with extensive flying in the Central and Western Pacific. This trip will offer both day and nighttime flying, and should provide a more accurate picture of user interoperability in the Oceanic environment.

