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FAA Office of NextGen (ANG)

REDAC / NAS Ops

Review of FY2022 – 2024 Proposed Portfolio

Name of Program: Weather Technology in the Cockpit (WTIC)

BLI Number: A12c

Presenter Name: Gary Pokodner

Date: 3/15/2022

Weather Technology in the Cockpit (WTIC) Program Overview

What are the benefits to the FAA

- 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

Weather Technology in the Cockpit (WTIC) Program Overview

What determines program success

- Number of standards released incorporating WTIC MinWxSvc recommendations
- Number of transitions of WTIC MinWxSvc recommendations into commercial products or operations
- Number of transitions of WTIC training materials to use in courses, textbooks, guidance, Wings Credit Courses, FAA pilot exam questions, and commercial training products
- Number of MinWxSvc recommendations incorporated by pilots and other stakeholders into practice, guidance, or endorsements by representative groups such as Aircraft Owners and Pilots Association (AOPA), Air Line Pilots Association (ALPA), and National Association of Flight Instructors (NAFI)
- Benefits analyses using model simulations and demonstration/operational data
- Tangible reduction in avoidable delays and aircraft accidents/incidents/risks due to weather

Weather Technology in the Cockpit (WTIC) Program Support

People:

- Program Managers:
  Gary Pokodner
- Subject Matter Experts:
  Ian Johnson (Human Factors),
  Eldridge Frazier (Engineering Lead)
- Contract Support:
  Joe Bracken (AvMet)

Laboratories:

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)
  - Future Flight Services
- NASA - Ames
- NTSB
- NCAR

Airlines
- Delta
- United
- American

Publishers
- Routledge

Standards Bodies
- RTCA
- ASTM

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
- ALPA
- Others (via GAJSC)
- NAFI

Industry
- Lockheed Martin (via PEGASAS)
- Frasca (via PEGASAS)
- Mindstar Aviation (via PEGASAS)
- Fly8Ma (vis PEGASAS)
- WebManuals (via PEGASAS)
- Aspen Avionics (via PEGASAS)

Current FY22 Accomplishments (Since Fall REDAC)

- **Crowd Sourcing Visibility Information**
  - Completed demo and data analysis using a configuration of crowd sourcing with MIT-Lincoln Lab (MITLL) edge detection software (running on the FAA experimental website)
  - Demonstrated results included capability of edge detection's switch to solicit crowd assessment, determination of expert crowd staffing numbers and scheduling techniques, capabilities of experts to assess visibility via a webcam image, identifying "ambiguous" conditions where ASOS and hybrid differed, and the value of providing sky conditions and cloud heights with a visibility estimate
  - A technical transfer package was delivered
  - Currently doing outreach to identify potential operational configurations and any research requirements to operationalize the capability
- **Determining Surface Winds with Machine Learning Software**
  - Successfully demonstrated use of Helios (an off-the-shelf product) to produce surface wind information with cameras and a wind sock
  - Analytics performed well on installs without site specific training, so the machine learning model was more robust than in a prior demonstration
  - Performing outreach to identify potential paths to operations

Current FY22 Accomplishments (Since Fall REDAC)

- **Industry Perspective on Weather Information and Technology in the Cockpit**
  - Completed question set and loaded it into the Alchemer online survey tool
  - The survey tool with the final question set is being evaluated by ALPA and NBAA, and then a data collection schedule will be implemented
  - Question set objectives are to identify gaps and obtain inputs/metrics on implemented WTIC Minimum Weather Service (MxWxSvc) recommendations

- **Pilot Report (PIREP) Voice Submission Tool**
  - Completed a two part test and associated test reports on the performance of the PEGASAS software to enable pilot voice-to-text submission of PIREPs
  - High level results indicated that the PEGASAS-developed prototype performed statistically better for PIREP submittal accuracy than the 5 off-the-shelf speech recognition software products used in the testing
  - On going research is to produce verified MinWxSvc recommendations to enhance the performance of the software

Current FY22 Accomplishments (Since Fall REDAC)

- **ADS-B Turbulence**
  - Completed Phase 3 of the research and received the final report along with a final briefing
  - Evaluated various techniques to compare ADS-B turbulence values to in-situ energy dissipation rate (EDR). Comparisons over multiple flights were encouraging, but still need to determine optimum technique.
  - Essential aspects of adaptive filtering to address contamination due to the quantization of the vertical rate output were identified and remained consistent
  - Began to focus on determining scaling factor to produce a turbulence output that scales into EDR, with the scaling accounting for the aircraft type and flight condition
  - Trade study determined that the correlation model approach to the adaptive filtering is preferable to the power spectral approach
  - Planning is underway for a limited demonstration of the algorithms performance to assess readiness for limited operational use

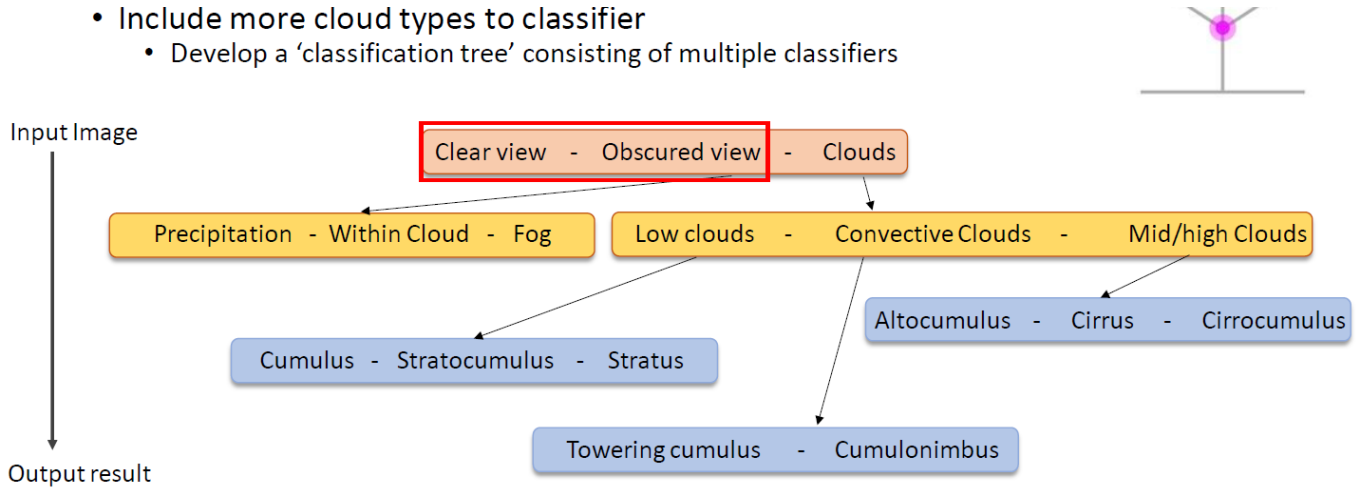
Current FY22 Accomplishments (Since Fall REDAC)

- **WeatherXplore and Augmented Reality Metrics and Partnership**
  - PEGASAS and ASA Inc. initiated a partnership for ASA to use the WeatherXplore technology (code/programming) for one book to evaluate its benefits and capabilities
  - Based on the results, ASA will determine if they will use it across a broader range of their aviation books
  - In FY22Q1, the augmented reality weather training mini courses on the Youtube channel had 32,624 pilot participants with 5,117 new viewers. The WMU site had 90 students complete all the courses with 5,207 new viewers. Fly8Ma had approximately 3,000 views for the quarter.

- **Remote Oceanic Meteorological Information Operations (ROMIO) and Global Weather Notification**
  - Prepared and provided outreach presentations on ROMIO and Global Weather Notification at the Turbulence Workshop and the Conference on ARAM to generate participation for the Technical Transfer Conference currently scheduled for May 2022

Current FY22 Accomplishments (Since Fall REDAC)

- **Develop "toolbox" to Identify Weather Sensor/Information Most Likely Representative of Non-Collocated Area of Flight**
  - Began evaluating correlation of climate zones with identification of most likely representative information source
  - Used machine learning to autonomously interpret cloud information from imagery and present concise, near-real time information to a common dashboard
  - Demonstrated feasible to use a machine learning framework, TensorFlow, to identify cumulus clouds and towering cumulus clouds (identified if one or both in an image)



Current FY22 Accomplishments (Since Fall REDAC)

- **Comparison of Self-Brief to Flight Specialist Brief Effectiveness**
  - Completed tasks to perform data collection including the design and development of the weather scenarios and the overall experimental design
  - Completed data collection on 25 participants with an additional 55 participants planned
  - Began coding of the behavioral observation data to enable statistical analysis of experiment results
  - Began processing the structured interview data to prepare it for analysis
  - Evaluating various scoring methods for the mental model assessments
  - Project is currently on schedule with a planned end date of February 2023
- **ADS-B PIREPs**
  - Completed technical support to RTCA's SC-186, WG-5 efforts to harmonize UAT ADS-B standards with the 1090ES ADS-B MOPS
    - Integrating ADS-B Wx, into DO-282C, the pending revision of the UAT ADS-B MOPS
  - The first draft of DO-282C was produced and made available for review within WG-5
  - The Final Review and Comment (FRAC) release version of the UAT MOPS is now available for public review and comment
  - Final status report delivered and technical support to RTCA for ADS-B PIREPs completed

Anticipated Research in FY23

Planned Research Activities

- Address gaps in VFR Not Recommended (VNR) MinWxSvc recommendations identified by Flight Services to enable automating VNR generation
- Development of MinWxSvc recommendations to operationalize “new observation data” produced via various crowd sourcing techniques
- Continue development of “toolbox” to assist pilots in the identification of most representative weather source/information when no collocated weather system
- Incorporating updates to ADS-B turbulence algorithms based on operational demo to enable an initial limited performance operational release
- Complete comparison of self-briefing versus specialist-briefing effectiveness

Expected Research Products

- Updated VNR MinWxSvc recommendations to resolve gaps in prior recommendations
- Updated technical transfer package to include recommendations to operationalize crowd sourcing techniques and outputs
- Research report and evaluation results supporting the development of the “toolbox”
- ADS-B turbulence algorithms mature enough for operational readiness assessment
- Final report on the effectiveness of preflight self-briefings compared to a specialist-briefing

Emerging FY24 Focal Areas

Emerging Areas will transition more towards data centric NAS

- Address ANSI Document UAS R&D Task of: “What are the applicable ways to replicate the capability of a “flight deck display” in UAS C2 systems for the purpose of displaying meteorological information?”
- Incorporating Wx information from advances and proliferation of Wx sensors into cockpit Wx information for safer and more effective adverse Wx avoidance
  - Collecting and sharing Wx observation information using emerging digital technologies
  - Virtual reality displays for cockpits to provide "visual" support for inadvertent flight into Instrument Meteorological Conditions (IMC) and other reduced visibility conditions
  - Develop/Utilize artificial intelligence or machine learning to identify weather information from sensors/sources, by weather element, that are most likely representative of the area of flight
  - Development of recommendations for cockpit rendering of Wx information from multiple sensor(s) not co-located in the area of flight or advisory

Emerging FY24 Focal Areas

- Standards to support Wx service providers by detailing the resolution, latency, data structure, quality, and update rate for each element of weather information data linked to the cockpit
  - Standards will also support development of advancing cockpit Wx automation and associated evolving pilot roles due to automation
- Developing automated preflight and in-flight planning tool(s) that incorporate numerous sources of MET information, flight plans / routing, and personal risk to provide probability of encounter or probability of success information
  - Develop a cockpit support tool with an “Alexa-like” capability building off MITRE digital co-pilot that enables pilots to ask weather questions as a cross-check to their own assessment of in-flight weather conditions. Base capability on types of weather questions asked to Flight Service Stations.

Weather Technology in the Cockpit (WTIC) Program

Research Requirements

- Develop Part 121/135 and Part 91 MinWxSvc recommendations for cockpit weather information and technology to enhance safety and efficiency, and reduce gaseous emissions
- Address the need for enhanced cockpit weather technology, information, and human factors principals to achieve NextGen objectives, and identify potential enhancements in a data centric national airspace system

Outputs/Outcomes

- Recommendations and white paper on operational uses of ADS-B Turbulence outputs
- Final report on initial research to replicate a “flight deck MET display” for UAS
- Final report on research results for MET applications for using increasing data link connectivity
- Plan for assessing potential applications of new weather information from technology advances
- New and updated FAA and RTCA standards and guidance

FY 2024 Planned Research

- Address ANSI Document UAS R&D Tasks related to replicating the display of MET information in cockpits
- Incorporate Wx information from advances and proliferation of Wx sensors into cockpit Wx information
- Identify the resolution, latency, data structure, quality, and update rate for each element of weather information data linked to the cockpit
- Develop automated preflight and in-flight planning tool(s) that incorporate numerous sources of MET information, flight plans / routing, and personal risk

Out Year Funding Requirements

RE&D

FY22	FY23	FY24
$1.76	$1.76M	$2.8M