REDAC / NAS Ops

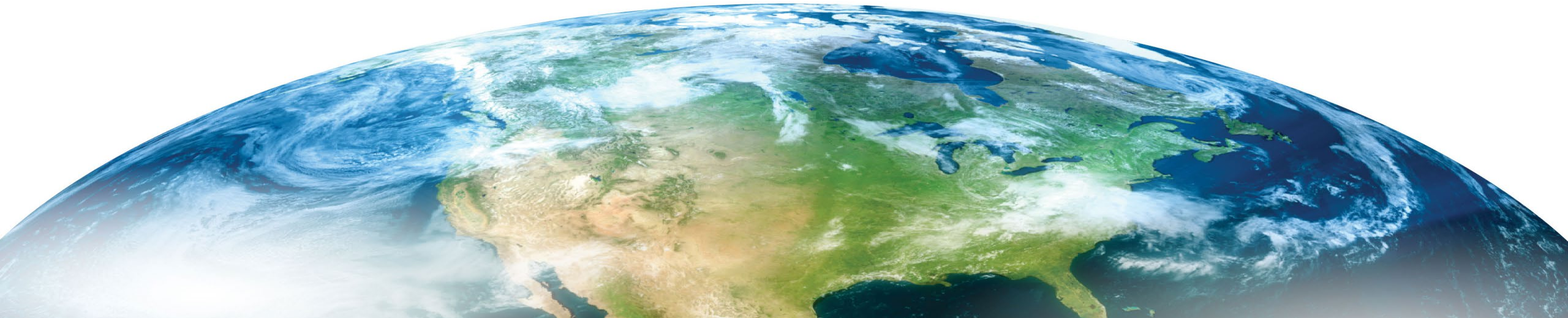
Weather Program

BLI Number: A11.j

Presenter Name: Randy Bass

Date: September 1, 2020

Review of FY 2020 - 2023
Proposed Portfolio



Weather Program A11.j
Overview

What are the benefits to the FAA

- Enhanced NAS safety via reduction of accidents associated with hazardous weather
- Improved NAS capacity/efficiency via reduced delays and cancellations and increased capacity in high traffic areas
- Reduction in environmental impact (i.e. lower fuel consumption via improved accuracy and accessibility of observed and forecast weather information)
- Enhanced GA safety via improved accuracy and accessibility of observed and forecast weather information

What determines program success

- Transition of research capabilities into evolving Air Traffic Management (ATM) decision support processes
- Research capabilities align with NSIP and NextGen emerging solution sets
- Incorporation by NWS of research capabilities to improve delivery of FAA required services
- Incorporation by NWS of research capabilities into weather information that is enhancing GA safety

Weather Program A11.j
Program Support

People:

- Program Manager and 12 Project Leads/Subject Matter Experts

Laboratories:

- NOAA ESRL – Numerical Wx Modeling (NWM), Quality Assessment, Terminal Area Icing Weather Information for NextGen (TAIWIN), Ceiling & Visibility (C&V)
- NOAA NSSL – Wx Radar Techniques, TAIWIN
- NOAA NCEP (EMC and AWC) – NWM, C&V
- NWS MDL – C&V
- MIT/LL – Convective Storms, C&V, Weather Observations (Wx Obs)
- NCAR – In-flight Icing, Turbulence, Convective Storms, C&V, NWM, TAIWIN, High Ice Water Content (HIWC), Wx Obs
- FAA Tech Center – Aviation Weather Demonstration and Evaluation (AWDE), Wx Obs, TAIWIN, HIWC
- NRC – TAIWIN
- ECCC – TAIWIN
- Diakon – TAIWIN
- NASA – HIWC, TAIWIN, In-flight Icing
- Australian Bureau of Meteorology – HIWC
- Metron Aviation, Inc. – Turbulence

Weather Program– Accomplishments in Current FY (20)

- **Convective Weather:** Updated the Ensemble Prediction of Oceanic Convective Hazards (EPOCH) operational algorithm to increase the probability of detection, lower the corresponding false alarm rate and account for bias corrections. Defined an expanded domain for the Offshore Precipitation Capability (OPC) for display on the OPC shadow web site which leverages the Global Synthetic Weather Radar effort of the US Air Force. Updated the replacement Convective Weather Avoidance Model (CWAM) to use the inputs of VIL and echo tops in a Convolutional Neural Network (CNN) model (The CNN allows for evaluation of other weather factors in the avoidance model).
- **Turbulence:** A final update of Graphical Turbulence Guidance-Global (GTGG) software was delivered to NOAA, including changes required to adapt to NOAA's latest global model. Without these modifications, GTGG could no longer be supported at EMC. Because the U.S. supports one of two International Civil Aviation Organization (ICAO) World Area Forecast Centers (WAFC) with the GTGG product, the capability is required to ensure safety of flight for international carriers. In addition, GTG-Nowcast (GTGN), a short term, rapidly updated turbulence capability, is pseudo-operational at the National Center for Atmospheric Research for operational user access; 11 users have signed licensing agreements (including airlines and commercial weather providers).
- **Ceiling and Visibility (C&V):** Conducted a Safety Risk Management Panel, which was approved, to determine risks associated with enhancements (new gridded analysis, 6-hr forecast, new display controls) to the Helicopter Emergency Medical Services (HEMS) tool; enhanced HEMS tool was operationally implemented at NOAA; demonstrated the Visibility Estimation through Image Analytics (VEIA) algorithm on the AvCams Experimental Website (https://avcamsplustest.faa.gov/) and began data collection for an independent Quality Assessment; transitioned C&V capabilities including enhanced treatment of sub-gridscale clouds and wildfire smoke effects into the High Resolution Rapid Refresh (HRRR) weather model for operational implementation.
- **In-flight Icing:** Completed analysis and recommendations for applying Geostationary Operational Environmental Satellite (GOES) and Next-Generation Radar (NEXRAD) enhancements for Current Icing Product (CIP). Completed baseline assessment of CIP applied to HRRR showing improvement.

Weather Program– Accomplishments in Current FY (20) (cont'd)

- **Modeling Development and Enhancement (MDE):** Transferred software code to NWS for 1Q FY21 operational implementation of Northern Hemisphere Rapid Refresh (RAP v5) model and CONUS and Alaska versions of the High Resolution Rapid Refresh (HRRR v4).
- **Advanced Weather Radar Techniques (AWRT):** Integrated Terminal Doppler Weather Radar (TDWRs) monitored for performance on the developmental Multi-Radar Multi-Sensor (MRMS) system. Algorithm for automatically creating convective SIGMET polygons developed. Specific flight levels for composite reflectivity product monitored for performance on the developmental MRMS system.
- **Quality Assessment (QA):** Completed assessment of the HRRR model upgrade from version 3 to version 4 which showed improved forecasts relevant to convective forecasts skill; Completed core research evaluating high-resolution forecasts against point observation which showed easier to understand skill scores; Completed verification plan for C&V camera based visibility estimates.
- **Aviation Weather Demonstration and Evaluation (AWDE) Services:** Collaborating with Aviation Weather Center (AWC) to plan and conduct the Summer Experiment which includes developing approaches for data collection and data collection tools. Collaborating with pertinent stakeholders for the Precipitation on the Glass (PoG) Table-top Assessment to develop assessment approach, scenarios, data collection tools, and identify participants.

Weather Program– Accomplishments in Current FY (20) (cont'd)

- **Terminal Area Icing Wx Information for NextGen (TAIWIN):** Completed In-Cloud ICing and Large-drop Experiment (ICICLE) Data Processing Workshop. Preparing for TAIWIN demonstration in Winter 21/22. Begin developing initial TAIWIN capability discriminating between Appendix C and Appendix O icing conditions in the terminal area.
- **High Ice Water Content (HIWC):** Supported development of Radar Ice Water Content airborne weather radar algorithm. Completed final year of HIWC Nowcasting Trial. Identified new validation opportunities for Algorithm for the Prediction of HIWC Areas (ALPHA) forecast product.

Anticipated Research in FY21

Planned Research Activities

- **Convective Weather:** Improve OPC, CWAM and the EPOCH capabilities. Incorporate revised algorithms and new data sets to expand domain and incorporate user feedback. Prepare EPOCH for transition to National Weather Service (NWS) and begin prep work for transition of OPC and CWAM to the NextGen Weather Processor.
- **In-flight Icing:** Continue development of enhanced CIP and Forecast Icing Product (FIP) using HRRR, GOES, and NEXRAD enhancements and data from the ICICLE field program.
- **MDE:** Commence experimental runs of Rapid Refresh Forecast System (RRFS) to replace HRRR including a common core with NWS models.
- **Turbulence:** Global Probabilistic Gridded Turbulence Forecast Product (RRFS (3 km)-based); High-resolution Graphical Turbulence Guidance (GTG) with Convectively Induced Turbulence forecasts; Turbulence Avoidance Model (TAM) for Air Traffic Control.
- **C&V:** Complete the quality assessment of the VEIA algorithm, develop a VEIA confidence value, determine when human input provides value to VEIA, and write an Operational Concept Description for VEIA. Increase the temporal resolution of Localized Aviation Model Output Statistics Program (LAMP) C&V forecasts and utilize satellite data to improve the performance between stations. Improve HRRR C&V capability through the assimilation of cloud products and post-processing diagnostics of cloud fields. Improve the quality control and display of non-certified weather observations in the Helicopter Emergency Medical Services (HEMS) tool.
- **AWRT:** Integrate new radar networks into MRMS. Improve the diagnosis of winter weather conditions through winter precipitation algorithm advancements.
- **QA**: Plan, coordinate, and conduct scientific meteorological assessments of HRRR-based CIP and FIP, FV3-based HRRR, and HRRR-based GTG (with capability of explicitly producing convectively-induced turbulence forecasts).

Anticipated Research in FY21 (cont'd)

Planned Research Activities

- **AWDE:** Conduct research to identify "platforms" to adequately conduct assessments virtually due to current COVID-19 pandemic. Conduct longer-term evaluation for IPA-D, develop use cases for pilots and dispatchers to support CONOPs development. Conduct interviews with airlines to determine concerns and needs regarding radiation effects on flight crew and passengers. Conduct human factor evaluations throughout the development of enhancements for the HEMS product. Conduct user evaluations for PoG, OPC, CWAM, HIWC, and TAIWIN.
- **TAIWIN:** Develop a TAIWIN capability that identifies and distinguishes between Appendix C and subsets of Appendix O icing conditions in the terminal area. Complete ICICLE data processing. Continue icing weather tool analyses using ICICLE datasets to improve the detection and discrimination of freezing drizzle and freezing rain diagnoses and forecasts.
- **HIWC:** Prepare for a FY22 flight campaign in high aerosol ice crystal icing environment. Conduct demonstration evaluation of ALPHA in the U.S.
- **Unmanned Aircraft Systems (UAS) Weather (Wx):** Start foundational R&D projects. Assess current weather research to determine alignment with gaps. Investigate accessibility of existing weather technology and information to UAS operations. Collaborate with FAA UAS community to ensure weather research supports UAS integration into the NAS and aligns with the FAA's vision of weather being a key Focus Area. Determine if on-going weather research for manned operations can be leveraged to support weather capabilities for unmanned operations.

Anticipated Research in FY21 (cont'd)

Expected Research Products

- **Convective Weather:** EPOCH forecast capability with higher Probability of Detection and lower False Alarm Rate. Tactical CWAM tool for incorporation into Numerical Weather Prediction (NWP). Increased geographic domain (to include Western U.S., Hawaii and Guam) of OPC, mitigate beam blockage issues in Western U.S. through OPC.
- **Turbulence:** TAM Prototype; High-resolution GTG with Convectively-induced turbulence forecasts experimental undergoes quality assessment.
- **C&V:** Improvements to VEIA algorithm. Gridded LAMP C&V forecasts with 15 minute temporal resolution, with improved performance between reporting stations. HRRR with improved C&V fields. HEMS display of non-certified weather observations.
- **In-Flight Icing:** High resolution diagnostic and forecast capabilities.
- **MDE:** Developmental version of RRFS.
- **AWRT:** 3D radar visualization product that automatically produces convective polygons.
- **TAIWIN:** TAIWIN capability that distinguishes between Appendix C and Appendix O as well as Appendix C and subsets of Appendix O in the terminal area. Processed ICICLE datasets.
- **UAS Wx**: Report on the concept of expanding implementation of existing capabilities, transitioning research efforts to operations, and identifying research opportunities, based on the operational feedback compiled from UAS test sites.

Anticipated Research in FY22

Planned Research Activities

Weather Program: Emphasis on integration of weather data and information into Decision Support Systems and Services. Transition to operations of successful weather projects into FAA, National Weather Service OR commercial weather provider systems.

- **Convective Weather:** Transition EPOCH to National Weather Service. Incorporation of near-term Traffic Flow Management (TFM) weather requirements.
- **Turbulence:** GTGN, High-resolution (RRFS (3km)-based).
- **C&V:** Development and testing of a super compact, low energy usage, ceilometer for use in remote areas with data gaps. Operational transition of VEIA. Continue development of LAMP and HRRR C&V fields.
- **In-Flight Icing:** Adapt diagnostic and forecast info to emerging high resolution weather prediction models in preparation for code transfer to NWS. Begin initial development of capabilities to support UAS operations.
- **MDE:** Development version of ensemble RRFS producing probabilistic weather forecasts.
- **AWRT:** Implement winter weather and convective products into the developmental MRMS system for performance monitoring.
- **QA:** Investigation of new techniques and data sources. C&V short-term forecasts. MDE forecasts.
- **AWDE:** User assessments of diagnosis and forecasting products including C&V analysis, turbulence, and convective weather products. Advance AWDE Concept and Product Capability for integration, evaluation and demonstration of future weather concepts and technologies.

Anticipated Research in FY22 (cont'd)

Planned Research Activities cont'd

- **TAIWIN:** Assess and validate MET data from NWP models, weather radars, and other data sources with ICICLE research flight data collected. Discrimination between freezing drizzle and freezing rain at surface and aloft in terminal area. Demonstrate TAIWIN and perform user evaluation.
- **HIWC:** Japan flight campaign.
- **UAS Wx:** Determine Urban Air Mobility weather needs. Identify existing weather capabilities for low altitude operations that may be applicable to UAS operations.
- **Weather Observations (Wx Obs):** Initiate exploration of new sensor technology to determine if sensor capabilities can be consolidated for future iterations of surface observing systems. Explore how various Liquid Water Equivalent (LWE) measurements during mixed-phase precipitation can be used to develop more robust determinations of LWE.

Expected Research Products

- **Turbulence:** Global Probabilistic Gridded Turbulence Forecast Product (RRFS (3 km)-based), experimental implementation.
- **C&V:** VEIA operational version available on https://avcamsplus.faa.gov/.
- **AWRT:** Development of web tool to display terminal-area winter weather hazards.
- **UAS Wx**: Initial set of weather observation and forecast requirements for UAM operations. Report on the use of existing weather capabilities that can support UAS domains.

Emerging FY23 Focal Areas

Weather Program: Continued emphasis on transition to operations of successful weather projects into FAA, National Weather Service and commercial weather provider systems. Development and implementation of weather standards for all segments of UAS

- **Convective Weather:** Scope/plan convective work against near-term TFM requirements; begin to target NAS sensitive areas for convective weather research.
- **Turbulence:** Continued development of probabilistic turbulence forecasting techniques. Incorporation of automated turbulence translation technique into traffic flow management decision support processes.
- **C&V:** Transition low energy ceilometer to visual weather observing system (VWOS); adapt VEIA to support sensor validation and issue reporting as part of VWOS.
- **In-Flight Icing:** Finalization of CIP and FIP code for transfer to NWS for operational implementation. Further development of drop-size capability to address aircraft certification envelopes. Further development of initial UAS capability.
- **MDE:** Initial version of RRFS finalized and transferred to NWS for operational implementation to include both deterministic and ensemble probabilistic weather forecasts.
- **AWRT:** Monitor performance of new products and algorithms on the developmental MRMS system, including winter precipitation algorithms and convective polygons.
- **QA:** Plan, coordinate, and conduct scientific meteorological assessments of Icing Drop Size and CONUS-AK, and UAS Weather.
- **AWDE:** Conduct assessments for Icing, Convective Weather, Turbulence, and C&V to ensure existing and emerging weather products enhance user decision making and support operational tasks. Conduct research to define information gaps to further enhance requirement development and design of weather products.

Emerging FY23 Focal Areas (cont'd)

- **TAIWIN:** Assess and validate MET data from NWP models, weather radars, and other data sources with ICICLE research flight data collected. Analyze results of TAIWIN evaluation with focus on operational implementation.
- **HIWC:** Data analysis from FY22 flight campaign. Evaluation of ice crystal icing certification envelope.
- **UAS Wx:** Development of standards and validation of forecast performance of numerical models in UAS domains.
- **Wx Obs:** Analysis of emerging automated weather detection and reporting technologies harmonized to the establishment and validation of NAS weather observation needs; specifically, exploring further automation of ground truth techniques to evaluate sensor capabilities to better distinguish obstructions to visibility such as fog and/or mist from moderate to heavy precipitation events.

Convective Weather

Research Requirement

- Improve observations and forecasts of convective weather and create and improve standards and techniques integration into (DSPs) to mitigate impacts on and improve efficiency of the NAS
- Improve accuracy over legacy systems; higher spatial and temporal resolution; well-defined probabilistic and gridded information; guidelines and strategies for developing capabilities for integration into DSPs that meet users' requirements and are applicable to their needs
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: Jason Baker, ANG-C61, 202-267-1625

Outputs/Outcomes

- OPC: Blend lightning data, satellite imagery and weather model data to produce an estimate of precipitation for areas that lack radar coverage, merged with existing radar mosaic to provide controllers with better situational awareness for offshore sectors
- CWAM: Redesign of the model to incorporate machine learning techniques and optimize use in strategic time frames (2-8 hour forecasts)
- EPOCH: Probabilistic convection guidance with lead times from 0 to 36 hours used for current operations and strategic planning of transoceanic flights

FY 2023 Planned Research

- Begin transition of the OPC to AJM for integration into NWP
- Begin transition of new CWAM to AJM for integration into NWP
- Complete transition of the EPOCH algorithm to operations at the NOAA/Environmental Modeling Center (EMC) for use by the Washington World Area Forecast Center
- Plan/scope convective weather performance against near-term TFM requirements; follow on to target convective weather work on NAS sensitive areas

Out Year Funding Requirements

FY20	FY21	FY22
$ 1.4M	$ 1.1M	$ 1.1M

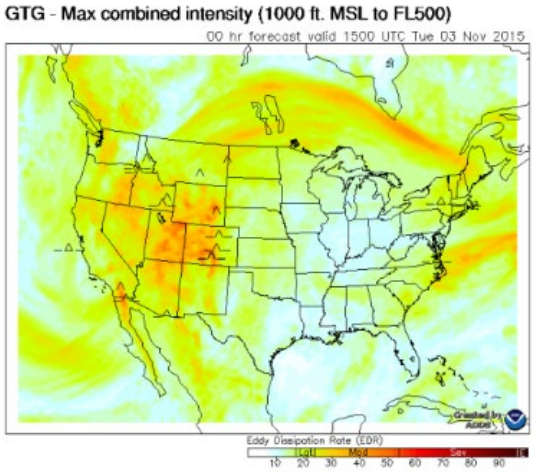
Turbulence

Research Requirement

- Improve turbulence observation and forecasting capabilities throughout the NAS to accurately identify & predict time, locations, & intensity of turbulence; improving safety, capacity, and efficiency in the NAS
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: Tammy Flowe, ANG-C61, 202-267-2796

Outputs/Outcomes

- High resolution, gridded, global detection and probabilistic forecasts of turbulence (clear-air, mountain wave & convectively-induced) to support ATM DSPs, dispatcher and pilots resulting in improved safety, increased capacity and reduced atmospheric emissions within the NAS



FY 2023 Planned Research

- GTG ensembles/probabilistic development matures
- Incorporation of automated turbulence translation technique into traffic flow management decision support processes

Out Year Funding Requirements

FY20	FY21	FY22
$ 1.1M	$ 0.8M	$ 0.8M

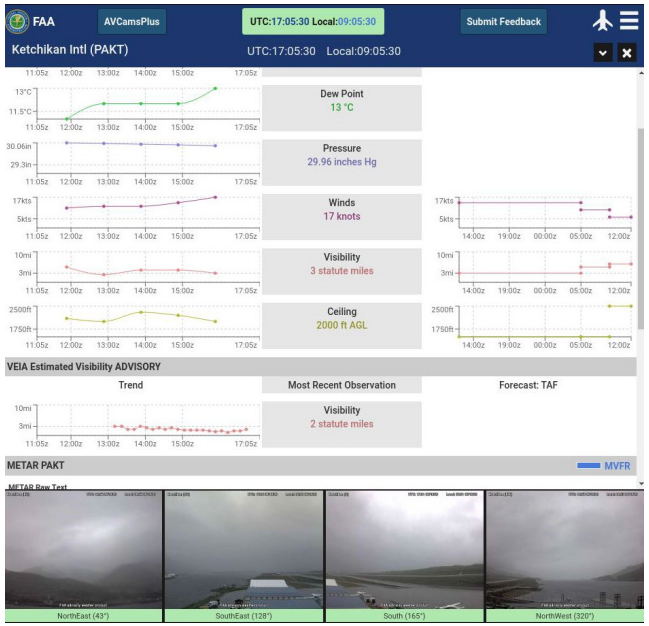
Ceiling and Visibility (C&V)

Research Requirement

- Improve C&V prediction models with the goal of reducing GA accidents/incidents and improving airport efficiency
- Applications for improved C&V predictions include support for current and future TAF Airmen's Meteorological Information (AIRMETS) and TRACON forecasts; production of automated TAFs in areas where no TAFs exists; updates to the HEMS tool; new observations in data-sparse regions
- Done in collaboration with NWS to improve products and services the FAA requires
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM, AVS
- POC: Jenny Colavito, ANG-C61, 202-267-2787

Outputs/Outcomes

- Improvements to C&V grids via LAMP and HRRR
- New sources for C&V observations: camera based visibility & low powered ceilometers
- Supports enhanced GA safety & ATM based decision support processes, dispatchers, and pilots resulting in improved safety



FY 2023 Planned Research

- Transition low energy ceilometer to visual weather observing system (VWOS)
- Adapt VEIA to support sensor validation and issue reporting as part of VWOS
- Continue development of LAMP C&V
- Continue development of HRRR C&V

Out Year Funding Requirements

FY20	FY21	FY22
$ 800K	$ 800K	$ 800K

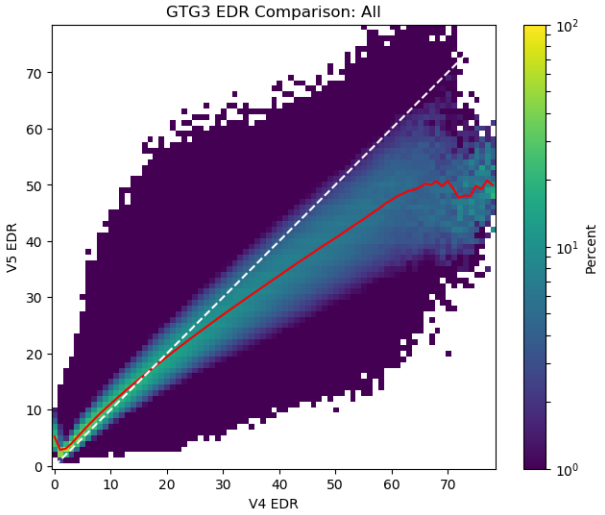
Quality Assessment (QA)

Research Requirement

- Improved observations & enhanced forecasts must have effective & reliable verification prior to becoming operational to ensure the accuracy, performance, and value of these products for NAS users
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: ANG-C63 Sean Whelan 609-485-4838; ANG-C63 Steve Maciejewski 609-485-5950

Outputs/Outcomes

- Verification/assessment of aviation impact weather forecasts and analyses
- Data provided supports transition of research weather forecast products based on forecast accuracy, quality, and operational meaningfulness to ATM, dispatchers, and pilots



FY 2023 Planned Research

- Icing Drop Size and CONUS-AK Assessment
- UAS Weather Assessment

Out Year Funding Requirements

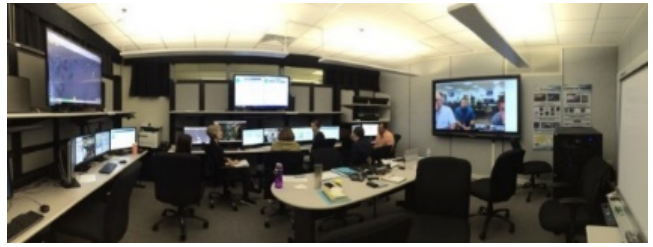
FY20	FY21	FY22
$ 1.2M	$ 1.0M	$ 1.0M

Aviation Weather Demonstration & Evaluation (AWDE) Services

Research Requirement

- NextGen Implementation Plan (Reduce Weather Impact & Validating Concepts) states human factors, human-in-the-loop testing and demonstrations are essential tools for validating NextGen concepts
- Demonstration and evaluation services are required to assess weather research maturity and concept readiness for transition
- Sponsored by ANG-C6, ANG-C7 AJV, AJR, AJM
- POC Sonia Alvidrez, ANG-C63; 609-485-7613

Outputs/Outcomes



- Enhanced demonstration and evaluation services with subject matter expertise, improved data resources including live aircraft situation data, and metrics capability
- Data & analysis to reduce programmatic risk, aid in definition & validation of requirements and inform Acquisition Management System (AMS) lifecycle management activities to improve the delivery of research capabilities developed

FY 2023 Planned Research

- Conduct assessments of diagnosis and forecasting capabilities including: Turbulence Forecasts; C&V Analysis; Convective Weather Forecast Statements; Ensemble research
- Participate/support the AWC Testbed Summer/Winter Experiments
- Continue working with Space Weather Prediction Center and other partners to further develop and define radiation effects on flight crew and passengers and determine airline needs in terms of radiation information

Out Year Funding Requirements

FY20	FY21	FY22
$ 500K	$ 500K	$ 500K

Terminal Area Icing Weather Information for NextGen (TAIWIN)

Research Requirement

- Responds to operational needs - new SLD Rule 25.1420 and NextGen *Reduce Weather Impact* capacity and throughput requirements in freezing precipitation
- Develop capability/technology to manage impact of new certification Supercooled Large Drops (SLD) rule on terminal area operations; research on automated reporting systems and improved weather diagnostic/forecast tools
- Sponsored by: AFS-200, AFS-400
- POC Stephanie DiVito, ANG-E2; 609-485-7152

Outputs/Outcomes

- Improved icing weather information including SLD in terminal area
- Maintain/improve efficiency and safety in icing conditions under new SLD rules in terminal area, facilitating smooth transition to new operational rules and/or guidance anticipated from Flight Standards corresponding to new SLD certification rule

FY 2023 Planned Research

- Continue analysis of ICICLE flight test data to quantify ability to diagnose and forecast detection and discrimination of freezing drizzle from freezing rain aloft in the terminal area
- Evaluate capabilities met vs. required for a final TAIWIN capability
- Focus on planning operational implementation

Out Year Funding Requirements

FY20	FY21	FY22
$ 1.6M	$ 1.3M	$ 1.3M

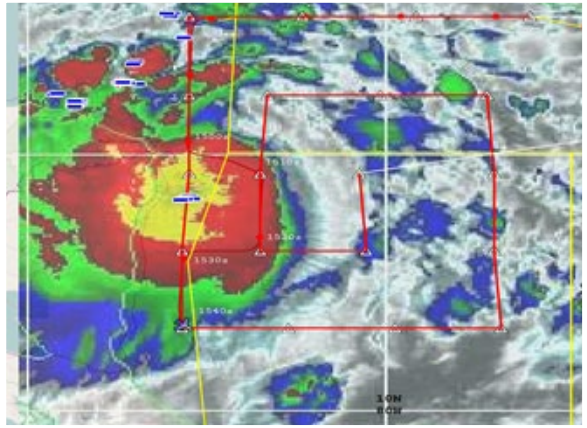
High Ice Water Content (HIWC)

Research Requirement

- NTSB: A-96-54, -56, & -58
- Characterization of HIWC ice crystal environments that can be a threat to turbine engines
- Diagnosis and forecasting of HIWC ice crystal environments
- Sponsored by AIR-6A1, AFS-400
- POC Jim Riley, ANG-E2; 609-485-4144

Outputs/Outcomes

- Atmospheric HIWC ice crystal data set sufficient for assessment of certification envelopes, development of test facilities, onboard detection for avoidance, and diagnosis and forecasting for avoidance
- Enhanced avoidance of HIWC conditions



FY 2023 Planned Research

- Analysis of FY22 flight data focusing on high aerosol impact on engine ice crystal icing
- Evaluation of ice crystal icing certification envelope
- Operational implementation path for ALPHA

Out Year Funding Requirements

FY20	FY21	FY22
$ 1.6M	$ 1.4M	$ 1.0M

UAS Weather

Research Requirement

- Gaps between current weather capabilities and weather information needed for safe and efficient airspace management of UAS operations
- The goals of the UAS Weather project are to further research identified gaps and explore the potential enhancement of current weather capabilities or development of new capabilities to close those gaps
- Sponsored by AFS 200,400,800, ANG-C6
- POC: Kevin Johnston, ANG-C64, 202-267-6377

Outputs/Outcomes

- Improved weather information required for safe and efficient UAS operations and integration into the NAS

FY 2023 Planned Research

- Continue collaboration with FAA UAS organizations
- Continuation of understanding weather needs for UAM operations
- Validation of forecast performance of numerical models in UAS Domains

Out Year Funding Requirements

FY20	FY21	FY22
N/A	$ 500K	$ 750K

Acronyms

- Airmet - Airmen's Meteorological Information
- AK - Alaska
- ALPHA – Algorithm for Prediction of HIWC Areas
- AMS – Acquisition Management System
- ATM – Air Traffic Management
- AWDE – Aviation Weather Demonstration and Evaluation
- AWRT – Advanced Weather Radar Techniques
- BOM – Australian Bureau of Meteorology
- CIP – Current Icing Product
- CNN – Convolutional Neural Network
- CWAM – Convective Weather Avoidance Model
- DSPs – Decision Support Processes
- ECCC – Environmental & Climate Change Canada
- EPOCH - Ensemble Prediction of Oceanic Convective Hazard
- FIP – Forecast Icing Product
- GA – General Aviation
- GTG – Graphical Turbulence Guidance
- GTGN – GTG Nowcast
- GOES – Geostationary Operational Environmental Satellite
- HEMS - Helicopter Emergency Medical Services
- HIWC – High Ice Water Content
- HRRR – High Resolution Rapid Refresh
- ICICLE – In-Cloud Icing and Large-Drop Experiment
- LAMP – Localized Aviation MOS Program
- MDL – Meteorological Development Laboratory
- MRMS – Multi-Radar, Multi-Sensor
- NAS – National Airspace System
- NRC – National Research Council of Canada
- NSIP – NextGen Segment Implementation Plan
- NTSC – National Transportation Systems Center
- NVM – Numerical Weather Modeling
- NWP – Numerical Weather Prediction
- NWS – National Weather Service
- OPC – Offshore Precipitation Capability
- SRMP - Safety Risk Management Panel
- SLD – Supercooled Large Droplet
- TAF – Terminal Area Forecast
- TAIWIN – Terminal Area Icing Wx Information for NextGen
- TDWR – Terminal Doppler Weather Radar
- TRACON – Terminal Radar Approach Control
- UAS – Unmanned Aircraft Systems
- VWOS - Visual Weather Observing System
- Wx - Weather
- Wx Obs – Weather Observations

Back Up Slides

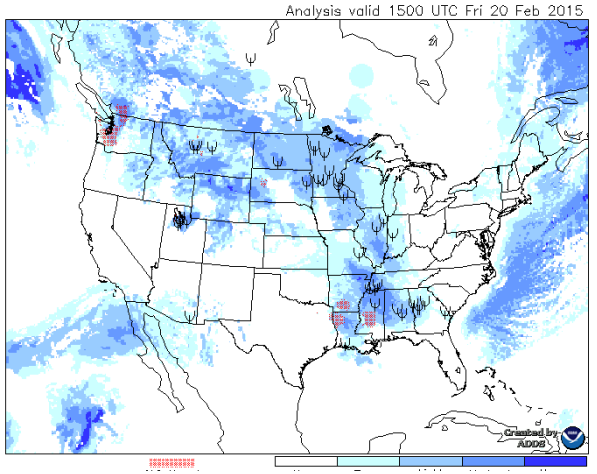
In-Flight Icing

Research Requirement

- Improve operationally-available, high-resolution, accurate diagnoses and forecasts of aircraft icing conditions that can be used by aviation users to make decisions on icing threat areas, optimum routings, and areas to avoid in compliance with recently updated regulations and aircraft certification envelopes
- Sponsored by ANG-C6, AVS, AJV, AJM
- POC: Danny Sims, ANG-C61, 202-267-2785

Outputs/Outcomes

- Diagnostic & forecasts up to and beyond 18 hours over the CONUS and Alaska for operational use by ATM, dispatchers, and pilots to enhance capacity and safety



FY 2023 Planned Research

- Transition enhanced CONUS and Alaska high resolution in-flight icing diagnosis and forecast capability to NWS for operational implementation
- Development of drop-size capability to meet aircraft certification envelopes

Out Year Funding Requirements

FY20	FY21	FY22
$ 1.3M	$ 1.3M	$ 1.3M

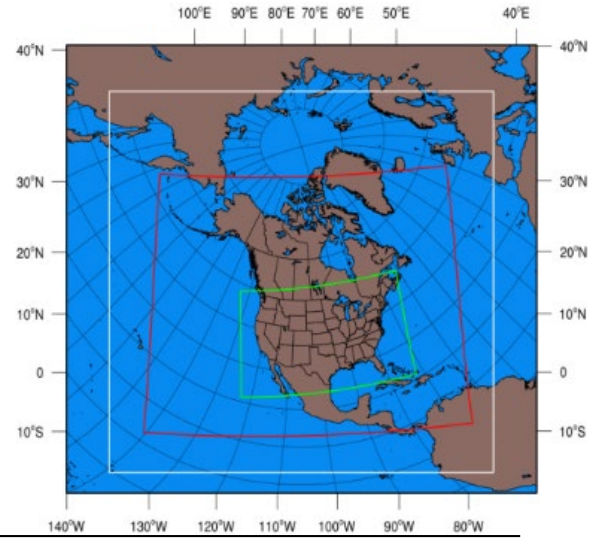
Model Development and Enhancement

Research Requirement

- Weather prediction models are the basis for all aviation weather hazard forecasts beyond 2 hours. Improvement of operationally available numerical weather prediction model resolution and refresh rates to enhance forecasts of aviation weather hazards including inflight icing, turbulence, convective weather, and ceiling and visibility will require model enhancements
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM, AFS, AIR
- POC: Danny Sims, ANG-C61, 202-267-2785

Outputs/Outcomes

- 0-48 hour high resolution rapid refresh to support aviation forecast products
- Enhanced NAS safety and capacity/efficiency from improved forecasts of aviation specific weather hazards



FY 2023 Planned Research

- Transfer initial RRFS code to NWS for operational implementation and replacement of HRRR.

Out Year Funding Requirements

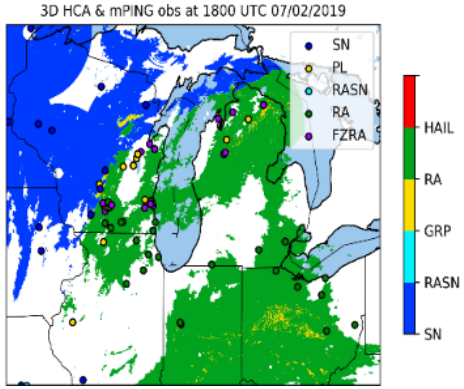
FY20	FY21	FY22
$ 1.0M	$ 1.0M	$ 1.1M

Advanced Weather Radar Techniques

Research Requirement

- Conduct and implement research toward a high-resolution, high quality, three-dimensional (3D) weather radar data analysis from national and international radar networks
- Provide improved detection and forecasting for hazardous phenomena such as turbulence, icing and convection, and deliver these products and services in a manner that allows for their rapid and effective use by NAS decision-makers
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: Randy Bass, ANG-C61, 202-267-2800

Outputs/Outcomes



- Provide aviation threat-specific information through the MRMS platform
- Provide reflectivity at specific flight levels beneficial to aviation users
- Improve diagnosis and depiction of icing conditions of interest to aircraft operations
- Improve validation techniques to ensure that MRMS data can be used effectively and reliably for operational decision-making
- Integrate TDWRs into the MRMS mosaic to improve detection and intensity of weather events

FY 2023 Planned Research

- Increase the spatial coverage of MRMS capabilities over offshore areas, including areas in the Caribbean, Mexico, and the Pacific
- Monitor performance of new products and algorithms on the developmental MRMS system, including winter precipitation algorithms and convective polygons

Out Year Funding Requirements

FY20	FY21	FY22
$ 492K	$ 380K	$ 380K

Weather Observations (Wx Obs)

Research Requirement

- Conduct and transition research that enhances or increases weather observations on the surface with the goal of improving capacity and surface operations.
- Evaluation of emerging observing technologies are required to validate user needs and assess readiness for formal concept demonstration and transition into operations.
- Sponsored by ANG-C6, AJV, AJM
- POC Victor Passetti, ANG-C63; 609-485-6260

Outputs/Outcomes

- Affirmation of automated weather detection capabilities synchronized to new or emerging weather observation requirements
- Reinforce the safety risk management process via early user interactions with new observing technologies to clarify desired needs and harmonize transition of new capabilities into existing weather observing platforms

FY 2023 Planned Research

- Continue exploration of new sensor technology to determine if sensor capabilities can be consolidated for future iterations of surface observing systems
- Continue assessment of various Liquid Water Equivalent (LWE) measurements during mixed-phase precipitation to determine which can be used to develop more robust determinations of LWE
- Explore further automation of ground truth techniques to evaluate sensor capabilities to better distinguish obstructions to visibility such as fog and/or mist from moderate to heavy precipitation events.
- Explore the sensitivity of measuring false accretions during “wet” snow events to develop a method for determining wet snow conditions utilizing the existing ASOS sensors (This is a potential shortfall in observations for UASs)

Out Year Funding Requirements

FY20	FY21	FY22
N/A	N/A	$ 500K