ANG The Future of the NAS Starts Here

FAA Office of NextGen (ANG)

REDAC / NAS Ops

Review of FY2022 – 2025 Proposed Portfolio

Name of Program: Weather Program

BLI Number: A11.k

Presenter Name: Randy Bass

Date: August 30, 2022

Weather Program A11.k 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 ATM decision support processes
- Research capabilities align with NSIP and NextGen emerging solution sets
- Incorporation by National Weather Service (NWS) of research capabilities to improve delivery of FAA required services
  - Weather Program funding of High-Resolution Rapid Refresh (HRRR) weather model while resulting in NAS benefits, has also provided high resolution severe weather forecasting; benefits to the energy community, est. $200M/yr. (enhanced wind prediction); improved freeze forecasts for specialty crops, est. $12.3M/yr.; 12-hour precipitation forecasts (commuter benefit minimizing late arrivals to work) -- Evaluating the Economic Impacts of Improvements to Weather Models – NOAA/Global Systems Lab – 18 Jan 2022
- Incorporation by NWS or commercial industry of research capabilities into weather information that enhances GA safety
- Tangible reduction in avoidable delays and aircraft accidents due to weather
  - Transition of successful weather research capabilities into operations have contributed to a reduction in NAS delays due to weather from 66% in 2007 to 57% in 2019

Weather Program A11.k
Program Support

People:

- Program Managers
- 12 Project Leads/Subject Matter Experts

Laboratories:

- NOAA GSL – In-flight Icing (IFI), Model Development & Enhancement (MDE), Quality Assessment (QA), Terminal Area Icing Weather Information for NextGen (TAIWIN), Ceiling & Visibility (C&V)
- NOAA NSSL – Advanced Wx Radar Techniques (AWRT), TAIWIN
- NOAA NCEP (Environmental Modeling Center and Aviation Weather Center) – MDE, IFI, Turbulence (TRB), C&V, Convective Storms (CS)
- NWS MDL – C&V
- MIT/LL – CS, C&V
- NCAR – IFI, TRB, CS, C&V, MDE, TAIWIN, High Ice Water Content (HIWC), Weather Observations (Wx Obs)
- FAA Tech Center (WJHTC) – Aviation Weather Demonstration and Evaluation (AWDE), Wx Obs, TAIWIN, HIWC
- NRC – TAIWIN
- ECCC – TAIWIN
- Diakon – TAIWIN
- NASA – HIWC, TAIWIN
- Metron Aviation, Inc. – TRB
- MITRE CAASD – Unmanned Aircraft Systems-Weather (UAS Wx), TRB

Current FY22 Accomplishments

- **Convective Storms (CS)**
  - Enhanced and released test website for user assessments of Offshore Precipitation Capability (OPC) development
  - Expanded geographical domain of OPC to include additional portions of the Atlantic Ocean, Gulf of Mexico and eastern Pacific
  - Provided OPC forecast capability to test website
  - Commenced transition of Ensemble Prediction of Oceanic Convective Hazards (EPOCH) to National Weather Service (NWS) to support international weather requirements; transition expected to be completed in FY23
- **In-flight Icing (IFI)**
  - Added advanced weather satellite and weather radar techniques to prototype Current Icing Product (CIP)
  - Advanced Forecast Icing Product (FIP) running in prototype Rapid Refresh Forecast System (RRFS) framework
- **Model Development and Enhancement (MDE)**
  - Continued development of RRFS aviation enhancements
  - Provided experimental RRFS output to testbeds for evaluation including the Aviation Weather Center testbed
- **Turbulence (TRB)**
  - Hosted virtual Turbulence Mitigation Workshop IV; 200+ participants over 3 days
  - Published peer-reviewed article in *Monthly Weather Review* documenting two case studies demonstrating the crucial effects of convection on Clear Air Turbulence (CAT)
  - Completed report on progress of developing global probabilistic turbulence forecasts in support of the World Areas Forecast System (WAFS)
  - Assisted Airbus in completing deployment of the Eddy Dissipation Rate (EDR) turbulence detection capability onto its A-350 fleet
  - Conducted transition discussions with NWS for GTG-N algorithm -- NTSB Recommendation
  - Established contract with MITRE CAASD for EDR Correlation Study – NTSB Recommendation

Current FY22 Accomplishments (contd.)

- **Ceiling and Visibility (C&V)**
  - Conducted Visibility Estimation through Image Analytics (VEIA) Safety Risk Management (SRM) Panel Meeting, and completed VEIA SRM Document for the display of VEIA on the WeatherCams operational website (weathercams.faa.gov); conducted analysis of VEIA when applied to WeatherCams new 360-degree camera set-up; analyzed performance of VEIA outside Alaska
  - Began development of Cloud Estimation through Image Analytics (CEIA) and conducted initial tests
  - Developed Localized Aviation Model Output Statistics (MOS) Program (LAMP) station-based probabilistic and deterministic C&V forecasts for 15-minute periods ending at 00, 15, 30, and 45 minutes past the hour, out to six hours -- four times the temporal resolution of the operational version for the first six hours
  - Commenced field study at Cincinnati/Northern Kentucky International Airport (CVG) to assess the use of drone-based observations to improve fog prediction
  - Hosted an all-day in-person/virtual Technical Exchange Meeting on the topic of Clouds, Cloud Ceiling, and Visibility with more than 50 participants from government, industry and academia
- **Advanced Weather Radar Techniques (AWRT)**
  - Deliverable reports completed:
    - Terminal Doppler Weather Radar (TDWR) integration into the NWS's Multi-Radar Multi-Sensor (MRMS) weather mosaic -- NTSB Recommendation
    - Improvements to MRMS quality control algorithm
    - Helicopter Emergency Medical Services algorithm development -- NTSB Recommendation
    - Hydrometeor phase classification and convective product algorithm advancement of clustering storms into single polygons, similar to SIGMETs
- **Quality Assessment (QA)**
  - Verification Plan for GTG-4 Assessment
  - Verification Plan for HRRR-based CIP and FIP assessment

Current FY22 Accomplishments (contd.)

- **Aviation Weather Demonstration & Evaluation (AWDE) Services**
  - Conducted OPC User Assessment with virtual interviews with ZSU, ZOA, and ZDV and onsite interviews at ATCSCC, ZMA, ZHU, and ZNY. Interviews were conducted with STMCs, TMCs, CPCs, Oss, NTMS, and NTMOs
  - Conducted an assessment for the GFA Experimental site, in coordination with the Aviation Weather Center Testbed & provided briefing summarizing feedback from General Aviation Pilots, Helicopter Pilots/Dispatchers, and Part 135 Pilots/Dispatchers
  - Conducted VEIA User Assessment, focusing on gathering feedback from GA Pilots, Part 121/135 Pilots, Part 121/135 Dispatchers, and Meteorologists
  - Conducted interviews for the AWC Summer Experiment focusing on the GFA Alaska expansion. Participants included: GA Pilots, Part 121/135 Pilots, Part 121/135 Dispatchers, and Meteorologists
  - Developed a ConUse document for the Icing Product Alaska-Diagnosis (IPA-D) detailing how Part 135/121 Pilots, GA Pilots, Part 135/121 Dispatchers, and Meteorologists use IPA-D to support decision making
  - Conducted assessment to determine the overall usability and suitability of the Algorithm for the Prediction of HIWC Areas (ALPHA) and TAIWIN products in providing support for decision making
- **Terminal Area Icing Weather Information for NextGen (TAIWIN)**
  - Completed demo and eval activity for the 1st version of the TAIWIN capability, performing research flights in Jan-Feb ‘22 & initializing output evaluation efforts
  - Initialized FY22-23 TAIWIN capability user demo and eval activity in coordination with AWDE Services

Current FY22 Accomplishments (contd.)

- **High Ice Water Content (HIWC)**
  - Conducted HIWC high aerosol campaign, performing flights in the Atlantic Ocean and Gulf of Mexico areas, with focus on collecting ice crystal icing aircraft data in high aerosol environments
  - Completed case studies comparing the Algorithm for the Prediction of HIWC Areas (ALPHA) and Convective Diagnostic Oceanic (CDO) products
  - Completed data collection period for FY22 ALPHA user demo & eval in coordination with AWDE Services
- **Unmanned Aircraft System Weather (UAS Wx)**
  - Updated report on ongoing UAS research efforts that may be candidates for technology transfer
  - Completed urban micro-scale weather (wind) sensitivity study for UAS integration advancement
    - Simulations at 6-meter resolution of Raleigh, NC to determine how landscape and buildings affect wind flow and turbulence below 400 feet for different wind speeds and directions
- **Weather Observations (Wx Obs)**
  - Demonstrated candidate message types for the present weather sensor to deliver to ASOS/AWOS allowing for the report of multiple precipitation types
  - Data collection completed at ACY and Marshall Field in Colorado
  - Performed requirements traceability with key ICAO, WMO and agency documents to highlight areas of ambiguity that will need to be clarified

Anticipated Research in FY23

Planned Research Activities

- **CS**
  - Integrate FAA Traffic Flow Management (TFM) requirements; target research in NAS sensitive/high traffic areas
  - Collaborate with Weather Evaluation Team (WET) to explore possible convective weather tasking to support Collaborative Decision Making (CDM)
  - Work with Weather Information Migration and Transition (WIMAT) to explore streamlining the number of convective weather products; “modernizing” convective weather products by digitizing those that are currently textual and/or graphical
  - Begin research and development efforts on any remaining initial Offshore Precipitation Capability (OPC) requirements for EnRoute Automation Modernization (ERAM)
- **IFI**
  - Assess increased performance of enhanced CIP
  - Prepare CIP software code for transition to NWS
  - Continue to assist NOAA GSL with FIP transition to NWS for FY24 implementation
- **MDE**
  - Finalize initial RRFS code in anticipation of FY24 implementation
  - Document performance of RRFS forecasts of aviation weather hazards

Anticipated Research in FY23 (contd.)

Planned Research Activities

- **TRB**
  - Turbulence Avoidance Model (TAM) prototype development, user evaluations
  - Eddy Dissipation Rate (EDR) algorithm correlation study – Year 1/Data Collect, Study Plan Development
  - Begin transition of GTG-N algorithm tailored for RRFS model to NWS
  - Investigate different methods of reporting turbulence from aircraft
- **C&V**
  - Complete field study at CVG airport to assess the use of drone-based observations to improve fog prediction
  - Complete initial testing of new CEIA algorithm; begin plan for CEIA Quality Assessment and User Assessment
  - Research methods to improve VEIA performance by analyzing scene characteristics and clustering images based on similarities
  - Develop San Francisco International Airport-specific LAMP guidance for cloud ceiling
- **AWRT**
  - Improve the Multi-Radar, Multi-Sensor (MRMS) quality control algorithm for light winter precipitation
  - Continue integration and testing of TDWR data into MRMS
  - Develop and test a radar mosaic for low-altitude flights

Anticipated Research in FY23 (contd.)

Planned Research Activities

- **QA**
  - Coordinate and conduct scientific meteorological assessments of icing drop size, upgrades to the CONUS – AK, high resolution modeling capabilities, C&V short-term forecasts, UAS Wx, GTG forecasts, and OPC mountain obscurations
- **AWDE**
  - Conduct an assessment focused on determining optimal design strategies for presenting flight categories onset and cessation when using a Terminal Aerodrome Forecast (TAF)
  - Conduct a TAIWIN user evaluation to determine the suitability and usability for potential users including Part 121 Pilots/Dispatchers, Part 91 Pilots, Part 107 Pilots, Part 135 Pilots, Part 107 Pilots, Center Weather Service Unit (CWSU) Meteorologists, and Air Traffic Controllers
  - Conduct exploratory research to identify UAS pilot icing information needs
- **TAIWIN**
  - Analyze results from demo & eval activities, focusing on operational implementation and validation/verification needs
  - Develop objectives for a validation/verification flight campaign for the high-resolution TAIWIN capability
  - Begin to incorporate a high-resolution temporal and spatial resolution to the gridded output of the TAIWIN capability (capability to communicate an icing diagnosis & forecast at horizontal and vertical points throughout the terminal area at high spatial & temporal resolutions)

Anticipated Research in FY23 (contd.)

Planned Research Activities

- **HIWC**
  - Particle size distribution analysis of data collected in the HIWC high aerosol flight campaign
  - Evaluate ice crystal icing certification envelope
  - Develop operational implementation path for ALPHA
- **UAS Wx**
  - Evaluate use of airport and off-airport observations to provide analyzed local information
  - Investigate hazardous weather alerting concepts for UAS operations
  - Commence urban/sub-urban micro-scale wind sensitivity study for UAS integration advancement for Winston-Salem, NC
- **Weather Observations (Wx Obs)**
  - Begin matrix of agency weather observing shortfalls with related ICAO/World Meteorological Organization requirements
  - Continue 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

Anticipated Research in FY23 (contd.)

Expected Research Products

- **CS**
  - EPOCH transitioned to NWS to provide better convective weather forecasts for the World Area Forecast System (WAFS)
- **IFI**
  - Enhance CIP and FIP transitioned to NWS for operational implementation
  - Developmental CIP and FIP drop size information to provide aircraft certification criteria guidance (performance-based standards to meet regulatory compliance)
- **MDE**
  - Finalize RRFS software code in preparation of FY24 operational implementation
- **TRB**
  - GTG-Global probabilistic forecast transition to experimental phase for WAFS
  - GTG-4 (RRFS-based) transition to NWS
- **C&V**
  - Real-time prototype of 15-minute forecasts of GLMP C&V guidance and report detailing the development and verification
  - Real-time prototype of a high resolution (1.25 km) LAMP gridded analysis of ceiling height observations for SFO area

Anticipated Research in FY23 (contd.)

Expected Research Products

- **AWRT**
  - Improved automated convective polygon designed to detect convection that poses threats to aviation
- **QA**
  - New verification techniques for analysis of gridded weather products
  - New verification techniques for analysis of probabilistic ensemble forecasts
  - Analyses of how users interpret forecast information
- **UAS Wx**
  - Analysis of weather products that support UAS operations for determination of minimum weather standards
  - Report on hazardous weather alerting concept
  - Simulations at 6-meter resolution of Winston-Salem, NC to determine how landscape and buildings affect wind flow and turbulence below 400 feet for different wind speeds and directions
- **Wx Obs**
  - Initial traceability document of observing shortfalls to ICAO/WMO requirements
  - Establish ground truth information for use in LWE mixed precipitation studies

Anticipated Research in FY24

Planned Research Activities

- **CS**
  - Continue research and development efforts on any remaining initial OPC requirements for ERAM
  - Begin transition of OPC into NextGen Wx Processor initial version; begin research on OPC v2 for remaining requirements
  - Expand the targeted CS research to operationally sensitive areas within the NAS
- **IFI**
  - Transition of enhanced CIP to NWS for implementation
  - Development of initial drop-size capability for CIP and FIP to address aircraft certification criteria
  - Begin development of initial UAS capability to adapt automated icing products
- **MDE**
  - Implementation of initial RRFS capability by NWS
  - Begin development of RRFS version 2 to include improved aviation weather forecasts

Anticipated Research in FY24 (contd.)

Planned Research Activities

- **TRB**
  - TAM Phase 4 - verification/validation by users, preparations for transition to operations via FAA CSS-Wx/NWP
  - Climate change effects on turbulence patterns for air routes
  - Turbulence mitigation capabilities for use in UAS/UAM operations
  - EDR Correlation Study – Year 2/Data Analysis
- **C&V**
  - Prepare LAMP and GLMP 15-min forecasts of C&V for handoff for operational implementation
  - Collect user feedback on prototype GLMP analysis of ceiling observations over the SFO domain, implement system for 15-minute update cycles
  - Continue to improve the visibility and cloud estimates from weather cameras and conduct third party quality assessment and user assessment of CEIA technology for implementation on the FAA Weather Camera website
  - Conduct a cost-benefit analysis for the use of fully-autonomous drone-based weather sensing systems near airports with high C&V impacts and complex terrain features
- **AWRT**
  - Continue integration and testing of TDWR data into MRMS
  - Continue improving hydrometeor classification and spectral bin classifier algorithms

Anticipated Research in FY24 (contd.)

Planned Research Activities

- **QA**
  - Assessments to include:
    - Ceiling and visibility capabilities for CONUS and Alaska
    - Capability of forecasting the size of super-cooled large droplets
    - Probabilistic Turbulence Forecasts
    - Enhancements to IFI for CONUS, Alaska, and global capabilities
    - GTG-N
- **AWDE**
  - Conduct user assessment to determine the overall usability and suitability of the a newly developed cloud cover product for Alaska
  - Conduct user assessment to determine the usability and suitability of the Global-Probabilistic GTG product
- **TAIWIN**
  - Continue development of high-resolution TAIWIN capability (capability to communicate an icing diagnosis and forecast at horizontal and vertical points throughout the terminal area at high spatial and temporal resolutions)
  - Evaluate capabilities met vs. required for a final TAIWIN capability
  - Prepare for flight campaign to collect data for validation and verification of high-resolution TAIWIN capability

Anticipated Research in FY24 (contd.)

Planned Research Activities

- **HIWC**
  - Complete the evaluation of ice crystal icing environments for the Appendix D certification envelope
  - If operational pathway for ALPHA has been identified, commence efforts to deploy ALPHA as an operational HIWC weather avoidance tool
- **UAS Wx**
  - Continue collaboration with FAA UAS organizations for understanding weather needs for Advanced Air Mobility and UAM operations
  - Validation of forecast performance of numerical models in UAS domains
- **Wx OBS**
  - Document human vs automated observing techniques for candidate shortfalls
  - Continue exploring automation of ground truth techniques for evaluating surface sensor capabilities to better distinguish obstructions to visibility such as fog and/or mist from moderate to heavy precipitation events

Anticipated Research in FY24

Expected Research Products

- **CS**
  - Additional functionality, output and information from OPC
- **IFI**
  - Initial assessment of CIP and FIP drop-size capability
- **MDE**
  - Development of RRFS version 2 with enhanced aviation weather forecasts
- **TRB**
  - GTG-N transition to operations at NWS
  - Final Report on EDR Correlation Study
- **C&V**
  - Gridded and station-based forecasts of high impact C&V and flight categories for CONUS for every 15 minutes going out 3-6 hours in the future, refreshed every 15 minutes
  - Cost-benefit analysis report for the use of fully-autonomous drone-based weather sensing systems near airports with high C&V impacts and complex terrain features

Anticipated Research in FY24 (contd.)

Expected Research Products

- **AWRT**
  - Winter weather and convective products implemented into the developmental MRMS system for performance monitoring
- **QA**
  - New verification techniques for analysis of gridded weather products
  - New verification techniques for analysis of probabilistic ensemble forecasts
- **Wx OBS**
  - Identify candidate sensor and system requirements for better discrimination of present weather and obstructions
  - Industry demonstration and evaluation of weather obstruction capabilities

Emerging FY25 Focal Areas

- **CS**
  - Plan/scope forecast for near-term TFM requirement, with focus on NAS high traffic sectors
  - Research possible alternatives to modernize TCF; begin developing convective weather end-to-end prototype
  - Continue operational transition of OPC; begin development on OPC version 2 to capture any remaining requirements
  - Complete “baseline/legacy” Convective Weather Avoidance Model (CWAM) research requirements for transition
- **IFI**
  - Continued development of drop-size capability
  - Continued development of low-level UAS capability
- **MDE**
  - Finalization of RRFS version 2 for NWS implementation
- **TRB**
  - TAM Phase 5 – Transition to operations within the FAA CSS-WX/NWP system
  - GTG enhancements – Outside cloud convectively-induced turbulence forecasts, extremely high-altitude forecasts, rapid updates (15 minutes)
  - GTGN Global version

Emerging FY25 Focal Areas (contd.)

- **C&V**
  - Improved C&V forecasts due to the assimilation of camera-based observation and other novel datasets
  - Enhancement of cloud analysis and forecast products to include cloud layers, scattered and few coverage, and uncertainty attributes as deemed useful for aviation decision making
  - Assessment of the impact of C&V on new NAS entrants (UAS, Urban Mobility, etc.)
- **AWRT**
  - Monitor the performance of winter precipitation algorithms, TDWRs, and convective polygons in developmental MRMS system
  - Investigate weather radar capability requirements for NWP and develop strategies for research opportunities in support of these requirements
- **QA**
  - Assessment of AWDE User Evaluations; improvements to VRMC infrastructure; core research activities

Emerging FY25 Focal Areas (contd.)

- **AWDE**
  - Continue user assessment for newly developed and/or redesigned weather products to ensure capabilities are usable and suitable
- **TAIWIN**
  - Validation and verification flight program for TAIWIN capability
- **HIWC**
  - Operational implementation of ALPHA as an operational HIWC weather avoidance tool
- **UAS Wx**
  - Continue collaboration with FAA and other organizations for understanding weather needs for Advanced Air Mobility and UAM operations
  - Investigate weather uncertainty concepts for UAS planning
- **Wx OBS**
  - Optimization of present weather sensor technologies to include one-to-one intensity/present weather reporting
  - Improved discrimination of present weather (snow) and weather obstructions (Fog/Mist)

Convective Storms (CS)

Research Requirements

- Improve observations and forecasts of convective storms. Create and improve standards and techniques integration into Decision Support Processes (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, AJM-3, AJR-B, AJV-S
- 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 seamlessly 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: Transfer to NWS to improve forecast for oceanic airspace
- TCF: More accurate forecast with infusion of high-resolution data and AI

FY 2025 Planned Research

- Plan/scope forecast for near-term TFM requirement, with focus on NAS high traffic sectors
- Research possible alternatives to modernize TCF; begin developing convective weather end-to-end prototype
- Continue operational transition of OPC; begin development on OPC version 2 to capture any remaining requirements
- Complete "baseline/legacy" Convective Weather Avoidance Model (CWAM) research requirements for transition

Out Year Funding Requirements

	FY22	FY23	FY24
RE&D	$1.6M	$ 1.6M	$ 1.6M

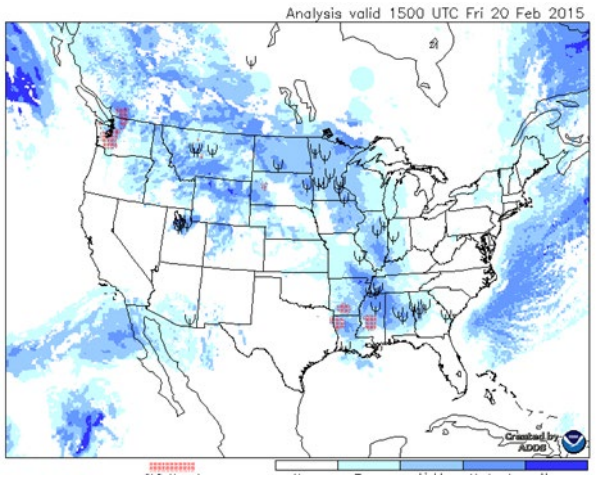
Inflight Icing (IFI)

Research Requirements

- Improve operationally-available 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, ANG-C7, AJM-3, AJR-B, AJV-S
- POC: Danny Sims, ANG-C61, 202-267-2785

Outputs/Outcomes

- Diagnostic and 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 2025 Planned Research

- Refine drop-size capability in icing products to meet aircraft certification envelopes
- Development of initial, prototype capability for low-level UAS operations

Out Year Funding Requirements

RE&D

FY22	FY23	FY24
$ 1.0M	$ 1.2M	$ 1.5M

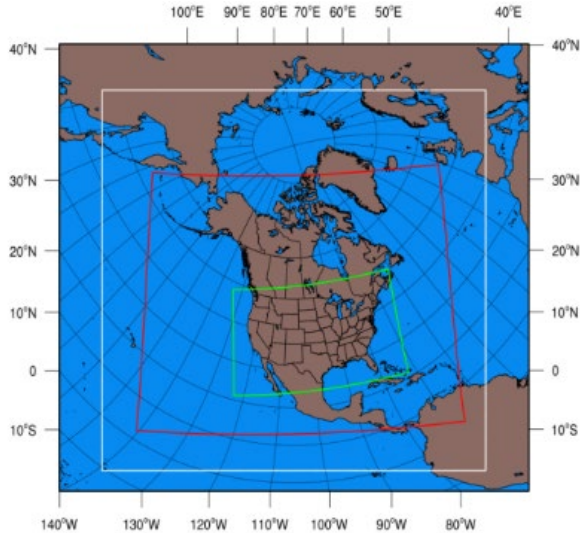
Model Development and Enhancement (MDE)

Research Requirements

- Weather prediction models are the basis for all aviation weather hazard forecasts beyond 2 hours. Improvement of operationally available numerical weather prediction models 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, AJM-3, AJR-B, AJV-S
- 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 2025 Planned Research

- Enhanced RRFS version 2 data assimilation
- Enhanced RRFS version 2 model physics

Out Year Funding Requirements

RE&D

FY222	FY23	FY24
$ 0.9M	$ 1.0M	$ 1.2M

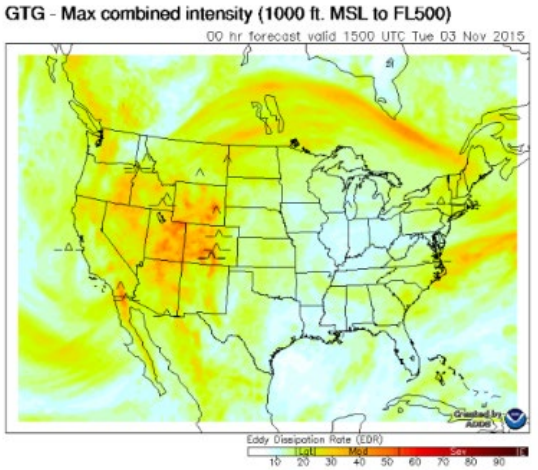
Turbulence (TRB)

Research Requirement

- Improve turbulence observation and forecasting capabilities throughout the NAS to accurately identify and predict time, locations, and intensity of turbulence; improving safety, capacity, and efficiency in the NAS
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S
- POC: Tammy Flowe, ANG-C61, 202-267-2796

Outputs/Outcomes

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



FY 2025 Planned Research

- TAM Phase 5 – Begin transition to operations within the FAA CSS-WX/NWP system
- GTG enhancements – Outside cloud convectively-induced turbulence forecasts, extremely high-altitude forecasts, rapid updates (15 minutes)
- GTGN Global version

Out Year Funding Requirements

RE&D

FY22	FY23	FY24
$ 1.0M	$ 1.0M	$1.0M

Ceiling and Visibility (C&V)

Research Requirements

- Improve C&V detection and prediction with the goal of reducing GA accidents/incidents and improving airport efficiency.
- Sponsored by ANG-C6, ANG-C7, AJM- 3, AJR-B, AJV-S
- POC: Jenny Colavito, ANG-C61, 202-267-2787

Outputs/Outcomes

- Improvements to C&V guidance at airports
- Improvements to and expansion of C&V gridded guidance
- New sources for C&V observations: camera-based and drone-based
- Enhanced GA safety, new NAS entrants, and ATM based decision support processes to improve efficiency

FY 2025 Planned Research

- Improve C&V forecasts and analyses through the assimilation of camera-based observations and other novel datasets
- Enhance of cloud analysis and forecast products to include cloud layers, scattered and few coverage, and uncertainty attributes as deemed useful for aviation decision making
- Assess the impact of C&V on new NAS entrants (UAS, Urban Mobility, etc.)

Out Year Funding Requirements

RE&D

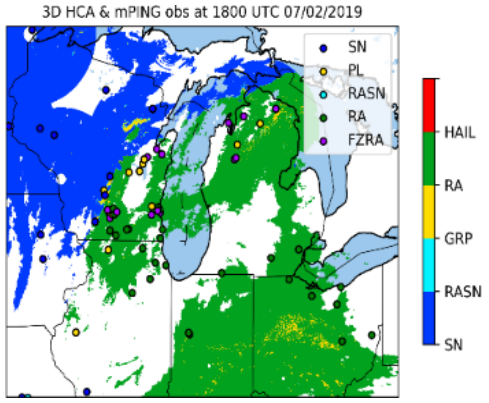
FY22	FY23	FY24
$ 1.0 M	$ 1.0 M	$ 1.5 M

Advanced Weather Radar Techniques (AWRT)

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, AJM-3, AJR-B, AJV-S
- POC: Randy Bass, ANG-C61, 202-267-2800

Outputs/Outcomes



- Aviation threat-specific information provided through the MRMS platform
- Reflectivity at specific flight levels beneficial to aviation users
- Improved diagnosis and depiction of icing conditions of interest to aircraft operations
- Improved validation techniques to ensure that MRMS data can be used effectively and reliably for operational decision-making
- Improved weather radar diagnosis and depiction of turbulence conditions of interest to aircraft operations

FY 2025 Planned Research

- Monitor performance of new products and algorithms on the developmental MRMS system, including winter precipitation algorithms and convective polygons
- Complete integration and testing of TDWR data into MRMS
- Investigate weather radar capability requirements for NWP and develop strategies for research opportunities in support of these requirements

Out Year Funding Requirements

	FY22	FY23	FY24
RE&D	$ 500K	$ 500K	$ 500K

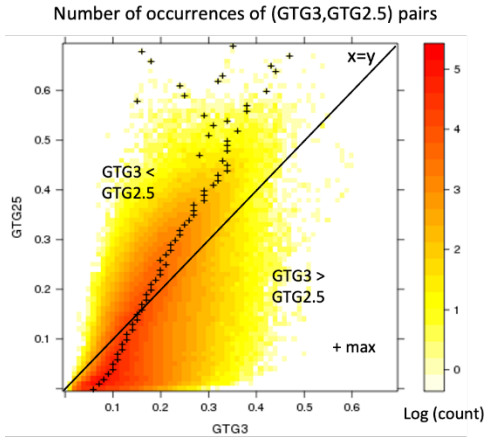
Quality Assessment (QA)

Research Requirements

- 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, AJM-3, AJR-B, AJV-S
- 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 2025 Planned Research

- Assessment of AWDE User Evaluations
- Improvements to VRMC Infrastructure
- Core Research Activities

Out Year Funding Requirements

RE&D

FY22	FY23	FY24
$ 1.0M	$ 1.0M	$ 1.0M

Aviation Weather Demonstration & Evaluation (AWDE) Services

Research Requirements

- 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, AJM-3, AJR-B, AJV-S
- 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 and analysis to reduce programmatic risk, aid in definition and validation of requirements and inform AMS lifecycle management activities to improve the delivery of research capabilities developed

FY 2025 Planned Research

- Conduct user assessments for Icing, Convective Storms, Turbulence, and C&V to ensure existing and emerging weather products enhance user decision making and support decision making
- Participate/support the AWC Testbed Summer and Winter Experiments

Out Year Funding Requirements

	FY22	FY23	FY24
RE&D	$ 550K	$ 550K	$ 550K

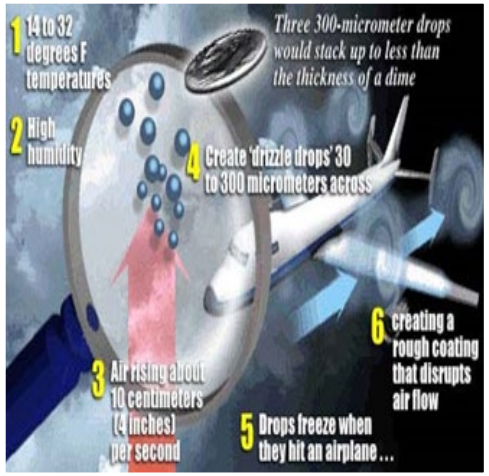
Terminal Area Icing Weather Information for NextGen (TAIWIN)

Research Requirements

- 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 2025 Planned Research

- Conduct flight campaign to collect data for TAIWIN capability validation/verification efforts
- Define next steps for operational transition activities

Out Year Funding Requirements

	FY22	FY23	FY24
RE&D	$ 1.4M	$ 1.6M	$ 1.6M

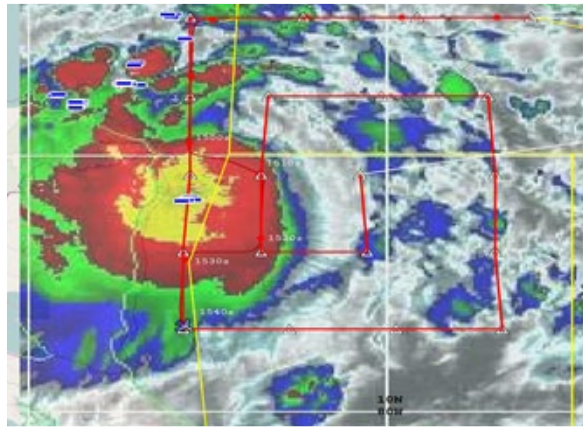
High Ice Water Content (HIWC)

Research Requirements

- 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-624, AFS-400
- POC Stephanie DiVito, ANG-E2; 609-485-7152

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 2025 Planned Research

- Given an operational pathway for ALPHA has been identified, perform efforts to deploy ALPHA as an operational HIWC weather avoidance tool

Out Year Funding Requirements

RE&D

FY22	FY23	FY24
$ 700K	$ 500K	$ 400K

UAS (Unmanned Aircraft Systems)-Weather

Research Requirements

- 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
- Support Operational Improvement for Qualified Weather Information
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S
- 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 2025 Planned Research

- Continue collaboration with FAA and other organizations involved with UAS
- Continuation of understanding weather needs for AAM and UAM operations
- Investigate weather uncertainty concepts for UAS planning

Out Year Funding Requirements

	FY22	FY23	FY24
RE&D	$ 500K	$ 500K	$ 500K

Weather Observations (Wx Obs)

Research Requirements

- 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, ANG-C7, AJM-3, AJR-B, AJV-S
- 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 2025 Planned Research

- Continue assessment of various LWE measurements during mixed-phase precipitation to determine which can be used to develop more robust determinations of LWE
- Continue to explore 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
- Continue to 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 UAS)
- Facilitate pre-concept demonstration activities for dual AWOS and ASOS baselines, such as tailored mission analysis and shortfall analysis

Out Year Funding Requirements

RE&D

FY22	FY23	FY24
$ 250K	$ 400K	$500K