ANG The Future of the NAS Starts Here

FAA Office of NextGen (ANG)

REDAC / NAS Ops

Review of FY2023 – 2026 Proposed Portfolio

Name of Program: Weather Program

BLI Number: A11.k

Presenter Name: Randy Bass

Date: August 23, 2023

Weather Program A11.K Overview

What are the benefits to the FAA

- Enhanced National Airspace (NAS) safety via reduction of accidents associated with hazardous weather (wx)
- 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 wx information)
- Enhanced General Aviation (GA) safety via improved accuracy and accessibility of observed and forecast wx information

What determines program success

- Transition of research capabilities into evolving ATM decision support processes
- Research capabilities align with NextGen Segment Implementation Plan 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 wx model while resulting in NAS benefits, has also provided high resolution severe wx 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 wx information that enhances GA safety
- Tangible reduction in avoidable delays and aircraft accidents due to wx
  - Transition of successful wx research capabilities into operations have contributed to a reduction in NAS delays due to wx from 66% in 2007 to 57% in 2019

Weather Program A11.K Support

People:

- 1 Program Manager
- 14 Subject Matter Experts

Laboratories:

• NOAA GSL	Model Development & Enhancement (MDE); Quality Assessment (QA)
• NOAA NSSL	Advanced Weather Radar Techniques (AWRT); Terminal Area Icing Weather Information for NextGen (TAIWIN)
• NOAA NCEP	MDE; Clouds, Cloud Ceiling, and Visibility (C&V); In-Flight Icing (IFI); Turbulence; (TRB); Convective Storms (CS)
• NCAR	IFI; MDE; C&V; TRB; CS; TAIWIN, High Ice Water Content (HIWC); Weather Observations Research (WOR)
• NWS MDL	C&V
• MIT/LL	CS; C&V
• WJHTC	Aviation Weather Demonstration & Evaluation (AWDE); WOR; TAIWIN; HIWC
• MITRE CAASD	Unmanned Aircraft System Weather (UAS Wx); Space Weather Aviation (SWxA); TRB
• NASA Langley	HIWC; Volcanic Ash Detection (VAD)
• NRC	TAIWIN
• Diakon	TAIWIN
• AvMet Applications	TAIWIN

Current FY23 Accomplishments

- **Convective Storms (CS)**
  - Commenced implementing AJV-S research guidance for Offshore Precipitation Capability (OPC) enhancements
  - Collaborated with AWDE on Traffic Flow Management (TFM) Convective Forecast (TCF) survey (184 responses received from industry, NWS, & FAA Air Traffic Controllers (ATC))
  - Finalized code & transitioned Ensemble Prediction of Oceanic Convective Hazards (EPOCH) to NWS to support international wx requirements
  - Closed Collaborative Decision Making (CDM)/Weather Evaluation Team (WET) tasking related to TCF: AWDE survey in collaboration with WET & industry determined training enhancements needed; updated training packages provided to industry and to FAA via eLMS
- **Inflight Icing (IFI)**
  - Updated internal processes for icing formation scenarios & enhanced satellite upgrades to improve performance of diagnosing large drop conditions
  - Developed plan for calibration of IFI probability & severity
  - Prepared Forecast Icing Product (FIP) version 2 for operational implementation by NWS
- **Model Development & Enhancement (MDE)**
  - Conducted Rapid Refresh Forecast System (RRFS) data assimilation experiments to demonstrate improvements, including improved wind forecasts
  - Upgraded RRFS microphysics to address convective weather (CW) shortfalls
  - Ran RRFS in Hazardous Weather Testbed, Flash Flood and Intense Rainfall Experiment, and Aviation Weather Testbed in order to collect feedback on performance

Current FY23 Accomplishments (contd.)

- **Turbulence (TRB)**
  - Provided overview on Graphical Turbulence Guidance (GTG) Version 4 (GTG4) transition efforts to Acting NextGen Administrator & new NWS Director
  - On-going transition discussions with NWS for transfer of GTG Nowcast (GTGN) model (short-term, rapidly updated tactical product) – National Transportation Safety Board (NTSB) Recommendation
  - Commenced EDR Correlation Study in response to NTSB recommendation
- **Clouds, Cloud Ceiling, & Visibility (C&V)**
  - Completed initial testing of Cloud Estimation through Image Analytics (CEIA) algorithm & determined technology shows promise for estimating cloud cover from wx cameras; & initial testing of an enhancement to Visibility Estimation through Image Analytics (VEIA) that uses scene-type designations (e.g., mountainous or flat terrain) to adjust VEIA configuration & improve overall visibility estimate performance
  - Completed data collection & final report for field study at CVG airport to assess the impact of meteorological observations from drones on prediction of fog events
  - Finalized Localized Aviation Model Output Statistics (MOS) Program (LAMP) based gridded forecasts with 15-minute temporal resolution for transition to NOAA NCEP for operational implementation
- **Advanced Weather Radar Techniques (AWRT)**
  - Quality control algorithm and TDWR 3D mosaic available live on experimental Multi-Radar/Multi-Sensor (MRMS) system
    - https://mrms-dev.nssl.noaa.gov/qvs/vmrms/viewer/

Current FY23 Accomplishments (contd.)

- **Quality Assessment (QA)**
  - Developed AWDE turbulence and inflight icing cases & interview questions
  - Updates to continuous improvements through verification
- **Aviation Weather Demonstration & Evaluation (AWDE) Services**
  - Coordinated with FAA WET & Industry leads to develop survey to determine how users, including ATC, Meteorologists, Dispatchers, & ATM, use and interpret TCF
  - Conducted TAIWIN User Assessment with: National Air Traffic Controllers Association (NATCA) Representatives, Meteorologists, Helicopter Pilots, Part 91 Pilots, and Part 107 Pilots. Overall, TAIWIN provides information needed to support decision-making & provides unique icing category information, including FZDZ/FZRA, not found in other icing products
  - Developed an Approach Document for Weather Information Modernization & Transition (WIMAT) CW Assessment that was delivered for initial feedback. Goal of assessment is to obtain aviation community feedback on the overall usefulness, suitability, and preference of each CW product
- **Terminal Area Icing Weather Information for NextGen (TAIWIN)**
  - Completed TAIWIN capability user demonstration & evaluation activity in coordination with AWDE
  - Initiated output evaluation of the development version of TAIWIN capability
  - Created preliminary nowcasting component of TAIWIN capability

Current FY23 Accomplishments (contd.)

- **High Ice Water Content (HIWC)**
  - Completed preliminary particle size distribution analysis of data collected in 2022 HIWC high aerosol flight campaign
  - Completed preliminary particle size distribution dataset
- **Unmanned Aircraft System Weather (UAS Wx)**
  - Commenced defining process & demonstrate development/application of forecast UAS micro-weather hazard information for Winston-Salem & discrete UAS mission scenarios
  - Supported outreach and interchanges (technical, mission, and concept-specific) as warranted with updated report on ongoing UAS research efforts that may be candidates for technology transfer
  - Completed urban micro-scale wx (wind) sensitivity study for UAS integration advancement; simulations at 6-meter resolution show how landscape & buildings affect wind flow & turbulence below 400 feet for different wind speeds & directions
  - Commenced translation of instantaneous & time-averaged microscale wx model results into preliminary UAS/UAM hazard fields, describing methodology as dependent upon vehicle type, mission type, & candidate landing / takeoff and routing structure
- **Weather Observations Research (WOR)**
  - Developed & demonstrated to Wx Program research teams a standard operating procedure for interfacing candidate wx sensors with a database-centric information collection process that allows for research into high priority observing shortfalls
  - Coordinated & conducted technical interchange with industry for the detection and reporting of boundary layer wx phenomena
  - Year-long collection and archive of precipitation, temperature, visibility and obscuration data from Marshal Field and at ACY

Current FY23 Accomplishments (contd.)

- **Space Weather Aviation (SWxA)**
  - Exploring/analyzing vendor capabilities & assessing contractual options
- **Volcanic Ash Detection (VAD)**
  - Coordinating with NASA Langley & their conduct of analysis to determine whether use of the “Swerling Technique” is viable to detect Volcanic Ash (VA)

Anticipated Research in FY24

Planned Research Activities

- **CS**
  - Commence planning & development of “proof of concept” forecast metrics for near-term TFM requirement, with focus on NAS high traffic sectors
  - Collaborate with WET to explore possible CS tasking to support CDM
  - Coordinate with WIMAT team to explore streamlining number of CW products; “modernize” CW products by digitizing those that are currently textual and/or graphical
- **IFI**
  - Development of initial drop size output capability
  - Finalize transition of FIP version 2 into NWS operations
  - Prepare Current Icing Product (CIP) version 2 for transition to NWS
- **MDE**
  - Evaluation of RRFS version 1 and transition to NWS for operational implementation
  - Continue RRFS version 2 research & development to address aviation wx hazards

Anticipated Research in FY24 (contd.)

Planned Research Activities (contd.)

- **TRB**
  - Continue transition of GTG4 and GTGN2 to NWS for operational implementation
  - Commence global GTGN product development
  - Expand research into climate change effects on turbulence & on the forecasting of persistent contrails & effects on climate
- **C&V**
  - Complete transition of LAMP & Gridded LAMP (GLMP) 15-min forecasts of C&V for transition to NWS for operational implementation
  - Prepare LAMP SFO-area ceiling guidance and onset and cessation products for transition to NWS for operational implementation
  - Continue to improve visibility & cloud estimates from wx cameras & conduct 3rd party QA of CEIA technology to prepare for implementation on FAA Weather Camera website
  - Complete wx drone study to determine optimal drone profiling configuration to predict fog at airports
- **AWRT**
  - Evaluate benefits of adding 3D mosaic of TDWR data into MRMS domain (NTSB Recommendation)
  - Monitor algorithm performance in developmental MRMS system (winter precip, TDWRs, convective polygons)
  - Improve QC algorithm for light winter precipitation

Anticipated Research in FY24 (contd.)

Planned Research Activities (contd.)

- **QA**
  - GTG4 and FIP2 assessments – RRFS Update; RRFS-based FIP2 vs IPA over the Alaska Domain
  - Impact-based Assessment of RRFS implementation
  - Core Research: C&V Flight Category Climatology; JPSS Satellite Investigation
- **AWDE**
  - Conduct User Assessment of CEIA to determine how cloud information will be used to support decision making when used in conjunction with AK camera images
  - Conduct User Assessment of LAMP Onset/Cessation of Flight Categories (FC) to determine solution more user suitable, provides most adequate information to determine onset & cessation of the FCs, & determine which class of users would benefit from using the info
  - Conduct research for WIMAT & CW to id CW products available to aviation community & how products are used

Anticipated Research in FY24 (contd.)

Planned Research Activities (contd.)

- **TAIWIN**
  - Using insights from planned evaluation activities, continue development of TAIWIN capability to provide horizontal and vertical icing diagnosis & forecast throughout terminal area at high spatial & temporal resolutions
  - Evaluate capabilities met vs. required for final TAIWIN capability
  - Design data collection activity (e.g., flight program) for validation & verification of high-resolution TAIWIN capability
- **HIWC**
  - Complete evaluation of ice crystal icing environments for Appendix D certification envelope
  - Analyze data collected in towering cumulus clouds during HIWC 2022 flight campaign to obtain inferences on effects of aerosols on HIWC environments
  - Pending operational pathway for Algorithm for Predicting HIWC Areas (ALPHA), commence efforts to deploy ALPHA as operational wx avoidance tool
- **UAS Wx**
  - Build on Raleigh-Durham and Winston Salem studies; focus on practical applications of previous research
  - Research use of developed concepts to support and enable operations with limited observational data: research feasibility to support EWINS type operational approvals with AFS; develop Concepts of Use for high resolution modeled urban wind information

Anticipated Research in FY24 (contd.)

Planned Research Activities (contd.)

- **WOR**
  - Optimization of present wx sensor technologies to include one-to-one intensity/present wx reporting
  - Improve discrimination of present wx (snow) & wx obstructions (fog/mist)
- **SWxA**
  - Investigate the viability of a data assimilation cutoff rigidity approach using US Space Force Responsive Environmental Assessment Commercially Hosted (REACH) payload data
  - Utilize vulnerability assessment results to further mitigate space wx effects on precision operations reliant upon GPS/GNSS and radiation exposure
  - Review existing datasets and missions for radiation observations & develop a plan to collect more measurements of radiation at aviation operating altitudes
- **VAD**
  - Continue to investigate the feasibility of detection using the Swerling Technique
  - Identify & collaborate with US Geological Survey personnel and other SMEs knowledgeable in VA characteristics/properties to determine requirements
  - Review, analyze, and determine wind tunnel test facility requirements & aircraft radar system/instrument requirements
- **Miscellaneous**
  - Develop weather research strategy plan in coordination with ATO and AJV weather strategy plans

Anticipated Research in FY24 (contd.)

Expected Research Products

- **CS**
  - Additional functionality, output & information from OPC
- **IFI**
  - Enhanced FIP version 2 running in NWS operations
  - Enhanced CIP version 2 software transitioned to NWS for operational implementation
  - Developmental CIP & FIP drop size information to provide aircraft certification criteria guidance (performance-based standards)
- **MDE**
  - RRFS version 1 implemented into NWS operations
  - Prototype RRFS version 2 with enhanced CW capabilities through improved data assimilation
- **TRB**
  - Initial GTGN2 code ready to transfer to NWS
  - EDR Correlation Study Phase 2 Report & Recommendations
- **C&V**
  - Gridded & station-based forecasts of high impact C&V & flight categories for CONUS every 15 minutes out 3-6 hours
  - High resolution gridded analysis of current ceiling conditions near SFO, updated every 15 minutes
  - Graphical display & text bulletins that communicate timing of onset & cessation of high impact conditions at Core 30 airports
  - Displays of estimated visibility and sky cover derived from FAA wx camera views

Anticipated Research in FY24 (contd.)

Expected Research Products (contd.)

- **AWRT**
  - Winter wx & convective products implemented into the developmental MRMS for performance monitoring
  - Automated first-guess output of convective SIGMETs for forecaster & end-user evaluation
- **QA**
  - New verification techniques for analysis of gridded wx products and for analysis of probabilistic ensemble forecasts
- **UAS Wx**
  - Shake & Sharp Decision tools developed to operational scenarios
- **SWxA**
  - Modernized method to generate real-time cutoff rigidity values from the US Space Force REACH payloads
  - Comprehensive database of existing radiation observations at aviation flight levels with an outlined proposal for obtaining more in-situ data

Anticipated Research in FY25

Planned Research Activities

- **CS**
  - Implement prototype metrics into select CW products to focus on NAS high traffic areas
  - Continue operational transition of OPC
  - Continue R&D to meet TFM requirements for CW; begin exploring AI/ML concepts
- **IFI**
  - Refine drop-size capability in prototype icing products to meet aircraft certification envelopes
  - Calibration update for probability and severity
  - Development of initial, prototype capability for low-level operations
- **MDE**
  - Preparation of RRFS v2 with enhanced model physics and data assimilation for NWS implementation
  - Initiate development of RRFS v3 with enhanced aviation specific capabilities including application to low-level operations
- **TRB**
  - Turbulence mitigation for UAS/AAM environment
  - Studies of climate change effects on turbulence patterns & air traffic routes; research improving forecasts of persistent contrails
  - GTG4 and GTGN2 transition to NWS for operational implementation

Anticipated Research in FY25 (contd.)

Planned Research Activities (contd.)

- **C&V**
  - Develop Gridded LAMP nest for ceiling height guidance for other airport areas
  - Cost-benefit analysis for fully-autonomous drone-based wx sensing system; develop real-time capabilities for wx-sensing drone data assimilation
  - Apply Observing System Simulation Experiment (OSSE) framework to Southern California region focusing on assessing drone-based observation impacts on fog/low ceiling predictions at Los Angeles airports
  - Participate in WMO wx-drone demo campaign by providing summaries of OSSE work for inclusion in WMO impact studies
- **AWRT**
  - Advance AI designed to automatically detect convection that poses a threat to aviation in MRMS and NextGen Weather Processor radar mosaics
- **QA**
  - RRFS upgrade and its impacts to the CW forecast
  - Probabilistic Turbulence Forecasts assessments
  - Continuous Improvement through Verification for modeling, turbulence, convection, and icing
- **AWDE**
  - Continue conducting user assessments for newly developed and/or redesigned wx products to ensure capabilities are usable and suitable for operational use
  - Continue to conduct research to identify wx capabilities and presentations to support decision making

Anticipated Research in FY25 (contd.)

Planned Research Activities (contd.)

- **TAIWIN**
  - Prepare TAIWIN Capability for a validation and verification activity in FY26, addressing remaining shortfalls and evaluations.
  - Prepare for a program in FY26 to collect data for TAIWIN capability validation/verification efforts
- **HIWC**
  - Transition ALPHA to an operational HIWC wx avoidance tool
- **UAS Wx**
  - Research use developed concepts to support and enable operations with limited observational data
  - Research feasibility to support EWINS type operational approvals with AFS
  - Develop Concepts of Use for high resolution modeled urban wind information
  - Research Non-std wx obs for supporting Urban UAS Operations including DOT roadside wx obs & traffic monitoring cams
- **WOR**
  - Optimization of present wx sensor technologies to include one-to-one intensity/present wx reporting
  - Improved discrimination of present wx (snow) & wx obstructions (fog/mist)
  - Initial investigation into automated smoke detection opportunities within existing observing equipment

Anticipated Research in FY25 (contd.)

Planned Research Activities (contd.)

- **SWxA**
  - Conduct OSSE to identify optimal, cost-effective ground-based neutron monitor network to support aviation radiation models
  - Continue data collection at heights between ground & low earth orbit (LEO) to improve aviation-based space wx models
  - Utilize citizen science to enhance & validate models (e.g., radiation dose & communication degradation)
- **VAD**
  - Software development and testing of radar algorithm approaches (e.g., Swerling algorithm approach) for detection of VA
  - Perform series of wind tunnel tests, using actual aircraft radar systems, with the identified VA medium and modified radar algorithm for detection of VA
- **Wind Detection & Forecast (WDF)**
  - Conduct initial sensor study to assess the benefits/impact of including LIDAR sensed wind observations, investigate performance benefit of including LIDAR data into numerical models, & assess performance impacts
  - Commence study to determine if Juneau Airport Wind System (JAWS) or a JAWS like system would be beneficial at other airports in the NAS; assess if current JAWS output could be provided solely by hi-res numerical models
  - Compare RRFS model output for winds at select, high demand, Core 29 airports to TFM Wind Requirements to establish baseline

Anticipated Research in FY25 (contd.)

Expected Research Products

- **IFI**
  - Initial prototype drop-size capability
  - Initial prototype capability for low-level operations
- **MDE**
  - Prepare RRFS v2 to transition to NWS for operational implementation
  - Prototype RRFS v3 with enhanced capabilities to support low-level aviation operations
- **C&V**
  - Improved C&V forecasts due to the assimilation of camera-based observation & other novel datasets
- **SWxA**
  - Results from the OSSE enabling future reconstruction and support of the existing neutron monitor network
  - Increased data collection at aviation altitudes, including up to LEO and down to Earth's surface

Emerging FY26 Focal Areas

- **CS**
  - Implement prototype metrics into CW products with focus on NAS high traffic sectors
  - Continue R&D to prepare OPC for operational transition
- **IFI**
  - Finalization of initial drop-size capability in icing products to meet aircraft certification envelopes
  - Further refinement and evaluation of prototype capability for low-level operations
- **MDE**
  - Implement RRFS v2 with enhanced model physics and data assimilation into NWS operations
  - Continued development of RRFS v3 with enhanced aviation specific capabilities including application to low-level operations
- **TRB**
  - Turbulence mitigation for UAS/AAM environment
  - Studies of climate change effects on turbulence patterns & air traffic routes
  - GTG enhancements – Outside cloud convectively-induced turbulence forecasts, extremely high-altitude forecasts, rapid updates (15 minutes)

Emerging FY26 Focal Areas (contd.)

- **C&V**
  - Incorporate VEIA observations in the GLMP system; improve GLMP AK C&V using satellite data
  - Extend OSSE studies to assess the value of symbiotic drone observations (observations obtained during flights with some other primary mission like package delivery) in prediction of fog and low ceilings
  - Prepare for demonstration of targeted drone-based technologies to support FAA's new Innovate-28 Program which targets AAM solutions for the summer 2028 Olympics in Los Angeles
- **AWRT**
  - Test & evaluate real-time performance of aviation threat-specific products through the MRMS platform
  - Evaluate the WSR-88D capability to provide required wind shear detection performance
  - Evaluate modified quality control algorithm that removes echoes of light precipitation, which can allow for improved situational awareness of terminal-area icing
- **QA**
  - Assessment of C&V capabilities for CONUS and Alaska
  - Assessment of enhancements to IFI for CONUS, Alaska, & global capabilities; and UAS Wx
- **AWDE**
  - Continue conducting user assessments for newly developed and/or redesigned wx products to ensure capabilities are usable and suitable for operational use
  - Continue to conduct research to identify wx product information requirements to support decision making

Emerging FY26 Focal Areas (contd.)

- **TAIWIN**
  - Validation & verification data collection program for TAIWIN capability
  - Define next steps for operational transition activities
- **HIWC**
  - Transition ALPHA to an operational HIWC wx avoidance tool
- **UAS Wx**
  - Non-Standard/Federal wx observation data sets
  - Non-traditional derived in-situ wx data sets supporting UAS Ops; power line fluctuations due to wind; further development of hi-res urban modeling DSPs
- **WOR**
  - Research addition of smoke detection and reporting capabilities within the ASWON program
  - Gap and shortfall analysis

Emerging FY26 Focal Areas (contd.)

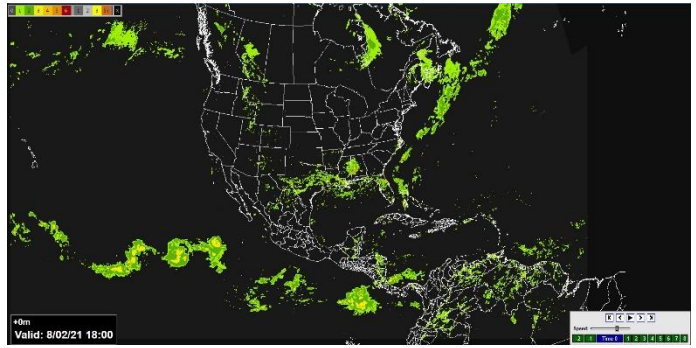
- **SWxA**
  - Leverage an operational satellite mission that would provide essential data for enhanced forecasting support
  - Reconstruct and support the existing but weakening neutron monitor network
  - Maximize radiation data collection at optimal altitudes using permanent dosimeters installed on all or nearly all aircraft
- **VAD**
  - Review, analyze, and determine aircraft requirements for an airborne flight campaign
- **WDF**
  - Continue initial sensor study to assess the benefits/impacts of including LIDAR sensed wind observations
  - Continue study to determine if JAWS or a JAWS like system would be beneficial at other airports in the NAS
  - Continue investigating if current JAWS output could be provided solely by high resolution modelling

Convective Storms (CS)

Research Requirements

- Improve observations & forecasts of convective storms. Create & improve standards & techniques for integration into Decision Support Processes (DSPs) to mitigate impacts on & improve efficiency of the NAS
- Improve accuracy over legacy systems; higher spatial & temporal resolution; well-defined probabilistic & gridded information; guidelines & strategies for developing capabilities for integration into DSPs that meet users' requirements & are applicable to their needs
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC: Jason Baker, ANG-C61, 202-267-1625

Outputs/Outcomes



- OPC: Blend lightning data, satellite imagery & wx 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
- TCF: More accurate forecast with infusion of high-resolution data & AI

FY 2026 Planned Research

- Implement prototype metrics into CW products with focus on NAS high traffic sectors
- Continue R&D to prepare OPC for operational transition

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$1.6M	$ 1.8M	$ 2.1M

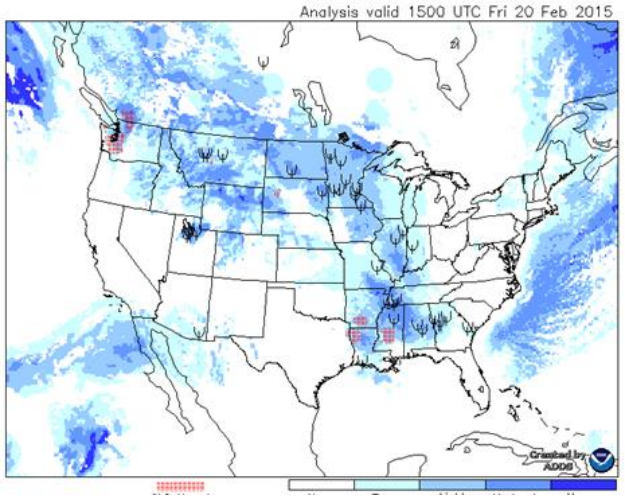
In-Flight Icing (IFI)

Research Requirements

- Improve operationally-available diagnoses & forecasts of aircraft icing conditions that can be used by aviation users to make decisions on icing threat areas, optimum routings, & areas to avoid in compliance with recently updated regulations & aircraft certification envelopes
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC: Danny Sims, ANG-C61, 202-267-2785

Outputs/Outcomes

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



FY 2026 Planned Research

- Finalization of initial drop-size capability in icing products to meet aircraft certification envelopes
- Further refinement and evaluation of prototype capability for low-level operations

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 1.0M	$ 1.2M	$ 1.5M

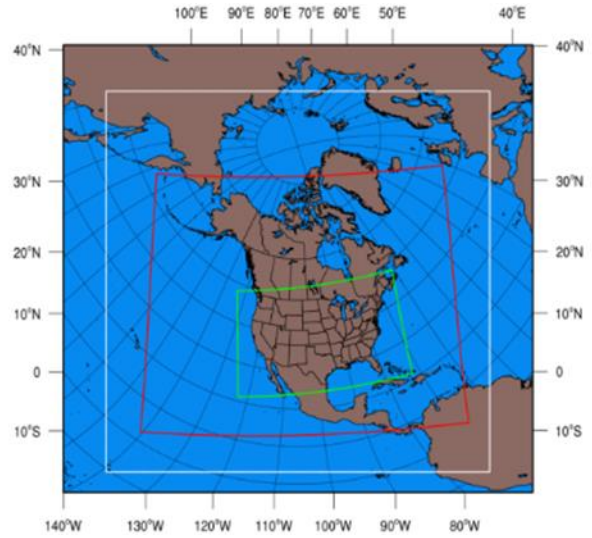
Model Development & Enhancement (MDE)

Research Requirements

- Weather prediction models are the basis for aviation wx hazard forecasts beyond 2 hours; enhancements to forecasts of aviation wx hazards including clouds & visibility, inflight icing, turbulence, and CW require wx prediction model enhancements
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC: Danny Sims, ANG-C61, 202-267-2785

Outputs/Outcomes

- 0-60-hour high resolution rapid refresh to support aviation forecast products
- Enhanced NAS safety & capacity/efficiency from improved forecasts of aviation specific wx hazards



FY 2026 Planned Research

- Implement RRFS v2 with enhanced model physics and data assimilation into NWS operations
- Continued development of RRFS v3 with enhanced aviation specific capabilities including application to low-level operations

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 1.0M	$ 1.2M	$ 1.2M

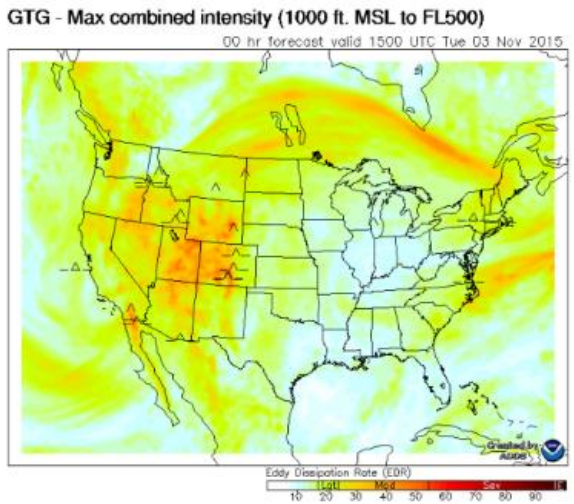
Turbulence (TRB)

Research Requirements

- Improve turbulence observation & forecasting capabilities throughout the NAS to accurately identify & predict time, locations, & intensity of turbulence; improving safety, capacity, & efficiency in the NAS
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S , AFS-400
- POC: Tammy Flowe, ANG-C61, 202-267-2796

Outputs/Outcomes

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



FY 2026 Planned Research

- Turbulence mitigation for UAS/AAM environment
- Studies of climate change effects on turbulence patterns & air traffic routes
- GTG enhancements – Outside cloud convectively-induced turbulence forecasts, extremely high-altitude forecasts, rapid updates (15 minutes)

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 1.5M	$ 1.5M	$ 1.5M

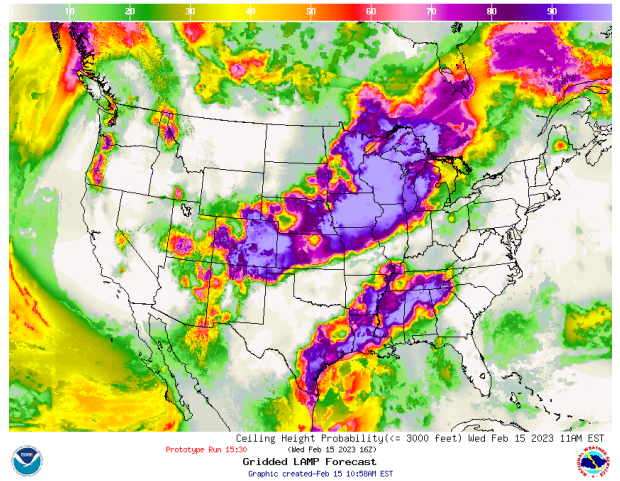
Clouds, Cloud Ceiling, & Visibility (C&V)

Research Requirements

- Improve C&V detection & prediction with the goal of reducing GA accidents/incidents & improving airport efficiency
- Sponsored by ANG-C6, ANG-C7, AJM- 3, AJR-B, AJV-S , AFS-400
- POC: Jenny Colavito, ANG-C61, 202-267-2787

Outputs/Outcomes

- Improvements to C&V guidance at airports leads to greater efficiency
- Improvements to & expansion of C&V gridded guidance
- New sources for C&V observations: camera-based & drone-based
- Enhanced safety for GA & new NAS entrants



FY 2026 Planned Research

- Incorporate VEIA observations in the GLMP system; improve GLMP AK C&V using Satellite data
- Extend OSSE studies to assess the value of symbiotic drone observations (observations obtained during flights with some other primary mission like package delivery) in prediction of fog and low ceilings
- Prepare for demonstration of targeted drone-based technologies to support the FAA's new Innovate-28 Program

Out Year Funding Requirements

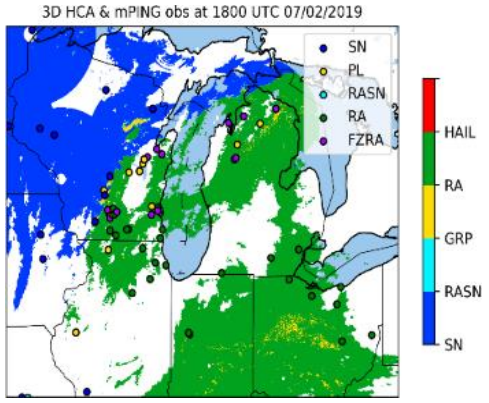
	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 1 M	$1.5 M	$1.5 M

Advanced Weather Radar Techniques (AWRT)

Research Requirement

- Conduct & implement research toward a high-resolution, high quality, three-dimensional (3D) wx radar data analysis from national & international radar networks
- Provide improved detection & forecasting for hazardous phenomena such as turbulence, icing & convection, & deliver these products & services in a manner that allows for their rapid & effective use by NAS decision-makers
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- 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 & depiction of icing conditions of interest to aircraft operations
- Improved validation techniques to ensure that MRMS data can be used effectively & reliably for operational decision-making
- Improved wx radar diagnosis & depiction of turbulence conditions of interest to aircraft operations

FY 2026 Planned Research

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

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 500K	$ 500K	$ 600K

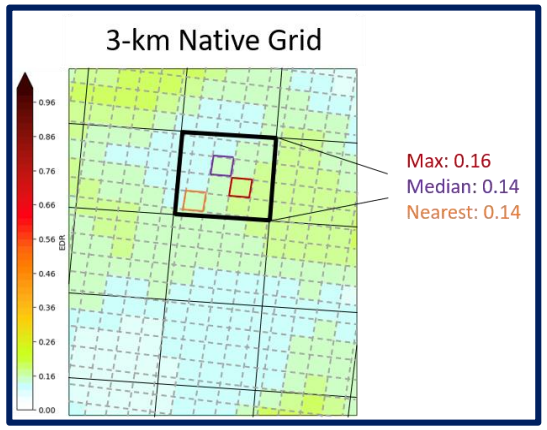
Quality Assessment (QA)

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, AFS-400
- POC: ANG-C63 Sean Whelan 609-485-4838; ANG-C63 Steve Maciejewski 609-485-5950

Outputs/Outcomes

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



FY 2026 Planned Research

- Assessments:
  - Ceiling and visibility capabilities for CONUS and Alaska
  - Enhancements to IFI for CONUS, Alaska, and global capabilities
  - Enhancements to UAS Wx

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 1.15 M	$ 1.15 M	$ 1.15 M

Aviation Weather Demonstration and Evaluation (AWDE)

Research Requirements

- NextGen Implementation Plan (Reduce Weather Impact & Validating Concepts) states human factors, human-in-the-loop testing, & demonstrations are essential tools for validating NextGen concepts
- Demonstration & evaluation services are required to assess wx research maturity & concept readiness for transition
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC Sonia Alvidrez, ANG-C63; 609-485-7613

Outputs/Outcomes

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

FY 2026 Planned Research

- Conduct user assessments for IFI, CS, TRB, and C&V to ensure existing & emerging wx products enhance user decision making
- Participate/support the AWC Testbed Summer & Winter Experiments

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 550k	$ 550K	$ 500K

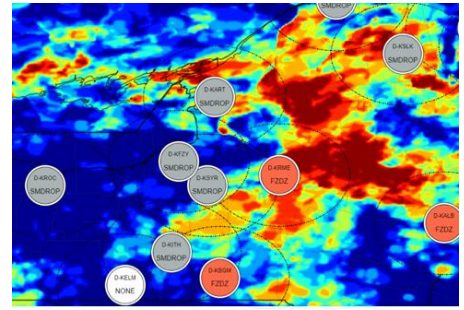
Terminal Area Icing Weather Information for NextGen (TAIWIN)*

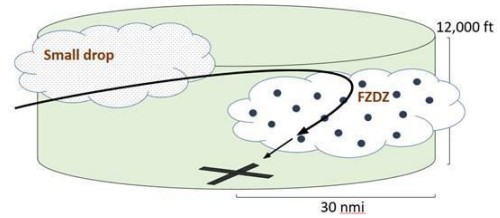
Research Requirements

- Responds to operational needs - new SLD Rule 25.1420 & NextGen *Reduce Weather Impact* capacity & 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 & improved wx diagnostic/forecast tools
- Sponsored by: AFS-200, AFS-400
- POC Stephanie DiVito, ANG-E2; 609-485-7152

Outputs/Outcomes

- Improved icing wx information including SLD in terminal area
- Maintain/improve efficiency & 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 2026 Planned Research

- Collect data for TAIWIN capability validation/verification efforts
- Define next steps for operational transition activities

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 1.6M	$1.6M	*$1.7M

*TAIWIN will be transitioning from A11.k to A11.da, Aircraft Icing BLI, and funded/managed by ANG-E2

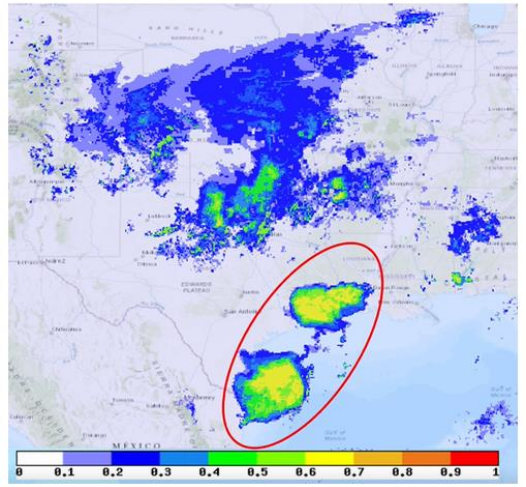
High Ice Water Content (HIWC)*

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, & diagnosis & forecasting for avoidance
- Enhanced avoidance of HIWC conditions



FY 2026 Planned Research

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

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$500K	$250K	*$50K

*HIWC will be transitioning from A11.k to A11.da, Aircraft Icing BLI and funded/managed by ANG-E2

Unmanned Aircraft System Weather (UAS Wx)

Research Requirements

- Assess & improve wx observation & forecast needs for UAS operations (Boundary layer (just above earth's surface; urban environment)
- New & refined wx information; observation & forecast, & decision support processes need defined standards to ensure continued high-level operational safety for the NAS
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400, AUS-300
- POC Pat Murphy, ANG-C61; 202-267-2788

Outputs/Outcomes

- Conduct research to identify how to improve wx observational networks and wx forecast models for low-altitude (below 400 feet) UAS operations

FY 2026 Planned Research

- Urban/Suburban Microscale Modeling for UAS & UAM Operational Concepts Development
- UAS Weather Research in the Boundary Layer
- Standard Specification for Wx Data Performance, Interfaces, & Interoperability
- UAS/AAM Integration Plan (UIRP)
  - FAA UIRP development & improvement
  - NASA-FAA UIRP development & improvement

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 250K	$ 750K	$ 750K

Weather Observations Research (WOR)

Research Requirements

- Conduct & transition research that enhances or increases wx observations on the surface with the goal of improving capacity & surface operations
- Evaluation of emerging observing technologies are required to validate user needs & assess readiness for formal concept demonstration & transition into operations
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC Victor Passetti, ANG-C63; 609-485-6260

Outputs/Outcomes

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

FY 2026 Planned Research

- Continue optimization of present wx sensor technologies to include one-to-one intensity/present wx reporting
- Continue improved discrimination of present wx (snow) & wx obstructions (fog/mist)
- Research addition of smoke detection and reporting capabilities within the ASWON program
- Gap and shortfall analysis

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 600K	$ 500K	$550K

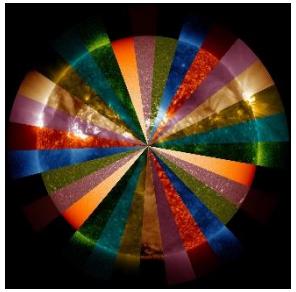
Space Weather Aviation (SWxA)

Research Requirements

- Space wx services will provide information for space wx events that may adversely affect the performance of aircraft communications, navigation, & surveillance systems
- Improved space wx information for aviation will consist of more accurate depictions & forecasts of the areas & altitudes affected by the space wx event
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC: Samantha Carlson, ANG-C61, 202-267-8990

Outputs/Outcomes

- Dosimeters on commercial, private, & governmental aircraft collecting in-flight data readily available to researchers to conduct forecast model validation
- Operational satellite mission supporting space wx forecasting for aviation needs
- Increased lead times for preflight planning & enroute diversions to save fuel, time, & limit radiation dosages to passengers & avionics
- Developed platform for citizen engagement/input allowing input for sing-point radiation exposure & communication issues



FY 2026 Planned Research

- Collect wx observations & measurements for enhanced forecasting support to provide increased accuracy & lead times, making the NAS safer & more efficient
- Utilize reported results from the OSSE enabling future reconstruction and support of the existing neutron monitor network
- Increase the collection of radiation information at optimum altitudes with regular dosimeter installations on all or nearly all aircraft

Out Year Funding Requirements

RE&D

FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
$500K	$500K	$500K

Volcanic Ash Detection (VAD)

Research Requirements

- Develop capability/technology to detect concentration of Volcanic Ash particles 60nm using an airborne radar
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC Karen Shelton-Mur, ANG-C64, 202-267-7985

Outputs/Outcomes

- Demonstration of detection of Volcanic Ash using a modified aircraft radar algorithm

FY 2026 Planned Research

- Continued software development and testing of radar algorithm approaches (e.g., Swerling algorithm approach) for detection of VA
- Continued wind tunnel tests with the identified VA medium and modified radar algorithm for detection of VA

Out Year Funding Requirements

RE&D

FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
$ 0	$ 150K	$ 300K

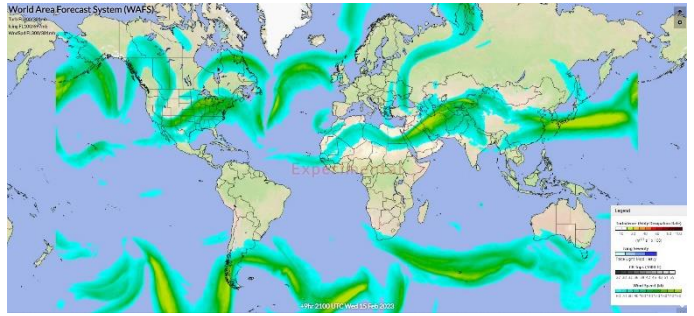
Wind Detection & Forecast (WDF)

Research Requirements

- Improvements to wind information throughout the NAS, focusing efforts on operationally significant areas, both geographically & vertically that cause flight delays, enhancing safety, increasing capacity, & reducing environmental impacts
- Sponsored by ANG-C6, ANG-C7, AJM-3, AJR-B, AJV-S, AFS-400
- POC Pat Murphy, ANG-C61; 202-267-2788; Jason Baker, ANG-C61, 202-267-1625

Outputs/Outcomes

- Improved wind speed/direction forecasts at/near surface including onset, cessation & dissipation of operational wind shifts
- Analyses of UAS, Comm. Space & TBFM needs



FY 2026 Planned Research

- Use a temporarily deployed LIDAR to evaluate optimal sensor siting locations around an airport
- Develop concepts to increase range of current LIDAR sensors
- Show benefit of adding LIDAR observations of mapping the wind flow & low-level winds aloft in the terminal airspace
- Assimilate high resolution LIDAR data into Model analysis

Out Year Funding Requirements

	FY23 (Enacted)	FY24 (President's Budget)	FY25 (CIP)
RE&D	$ 0	$ 0	$ 1.1M

List of Acronyms

- **AAM** Advanced Air Mobility
- **ASWON** Aviation Surface Weather Observation Network
- **AI** Artificial Intelligence
- **ALPHA** Algorithm for Predicting HIWC Areas
- **ATC** Air Traffic Controllers
- **ATM** Air Traffic Management
- **CDM** Collaborative Decision Making
- **CEIA** Cloud Estimation through Image Analytics
- **CIP** Current Icing Product
- **CONUS** Continental U.S.
- **CW** Convective Weather
- **EDR** Eddy Dissipation Rate
- **EPOCH** Ensemble Prediction of Oceanic Convective Hazards
- **EWINS** Enhanced Weather information Systems
- **FIP** Forecast Icing Product
- **FZDZ** Freezing Drizzle
- **FZRA** Freezing Rain
- **GA** General Aviation
- **GLMP** Gridded LAMP
- **GNSS** Global Navigation Satellite System
- **GPS** Global Positioning System
- **GTG** Graphical Turbulence Guidance
- **GTGN** GTG Nowcast
- **JAWS** Juneau Airport Wind System
- **JPSS** Joint Polar Satellite System
- **LAMP** Localized Aviation MOS Program
- **LEO** Low Earth Orbit
- **LIDAR** Light Detection and Ranging
- **ML** Machine Learning
- **MOS** Model Output Statistics
- **MRMS** Multi-Radar/Multi-Sensor System
- **NAS** National Airspace
- **NATCA** National Air Traffic Controllers Association
- **NTSB** National Transportation Safety Board
- **NWS** National Weather Service
- **OPC** Offshore Precipitation Capability
- **OSSE** Observing System Simulation Experiment
- **REACH** Responsive Environmental Assessment Commercially Hosted
- **RRFS** Rapid Refresh Forecast System
- **SIGMET** Significant Meteorological Information
- **TCF** TFM Convective Forecast
- **TDWR** Terminal Doppler Weather Radar
- **TFM** Traffic Flow Management
- **UAM** Urban Air Mobility
- **VEIA** Visibility Estimation through Image Analytics
- **WIMAT** Weather Information Modernization & Transition
- **WET** Weather Evaluation Team