



Federal Aviation
Administration

REDAC / NAS Ops

*Review of FY 2018
Proposed Portfolio*

Weather Program

BLI Number: A11.k

Steve Abelman, ANG-C6

March 8, 2016



Program Overview

What is this program?

Purpose

- Applied research to minimize the impact of weather on the NAS
 - Specific initiatives to support NextGen weather Operational Improvements contained in the NextGen Implementation Plan
 - Collaborative, complimentary initiatives with NWS to transition legacy capabilities to meet NextGen requirements
 - Focused initiatives to help mitigate safety and/or efficiency issues associated with well documented weather problems

Funding

FY15 (Enacted)	FY16 (Enacted)	FY17 (Request)	FY18 (Target)
\$13.7M	\$13.8M	\$16.7M	\$16.9M

Weather Program

A11.k

What are the benefits to the FAA

- Enhance NAS safety via reduction of accidents associated with hazardous weather
- Improve 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 tools
- 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

FY18 Wx Program Portfolio

Core Wx Program	Reduce Accidents and Fatalities Related to In-Flight Icing (IFI) Encounters
	Improve Capacity of NAS and Reduce Accidents Related to Turbulence (TRB)
	Provide Improved Thunderstorm Information to increase NAS efficiency, capacity, and safety (CW)
	Develop Alaska Ceiling and Visibility (C&V) Analysis for (CVA-AK)
	CONUS Ceiling and Visibility (C&V) Research
	Perform Quality Assessment (QA) to verify and validate relevant weather nowcast and forecast capabilities
	Develop and Improve Aviation Weather Numerical Modeling Capabilities to improve safety and capacity of the NAS (MDE)
	Provide aviation weather demonstration, evaluation (AWDE) services to assess aviation weather research concepts to improve the delivery of capabilities
	Integrate high resolution 4D weather radar analysis in support of safety and capacity in the NAS (AWRT)
	Improve Forecasts of Volcanic Ash cloud location and extent to support global harmonization (VA)
	Application of Uncertainty in ATM Decisions Associated with Weather
AVS Wx	Mitigating the Ice Crystal Weather Threat to Aircraft Turbine Engines (HIWC)
	Terminal Area Icing Weather Information for NextGen (TAIWIN)
	Convectively Induced Turbulence (CIT) - Extent/Severity/impact on Aviation
	Validation of Advanced Airborne Radar Weather Hazards Detection
	Safety Driven Weather Requirements for Wake Mitigation

FY18 AVS Wx Portfolio

AVS sponsored and prioritized research initiatives to address select safety concerns in the short and mid-term time horizon, but consistent with current and future requirements

Develop Terminal Area Icing Weather Information for NextGen

Improved icing weather information including SLD in terminal area in response to new SLD certification rule

Mitigate the Ice Crystal Weather Threat to Aircraft Turbine Engines

HIWC ice crystal data set sufficient for assessment of certification envelopes, development of test facilities, and diagnosis and forecasting for avoidance

Convectively Induced Turbulence - Extent/Severity/Impact on Aviation

Conduct assessment of CIT impacts on NAS – results will enhance NAS capacity/safety with a primary focus on GA pilots through tool development for use in GA cockpit

Validation of Advanced Airborne Radar Weather Hazards Detection

Evaluation of capability of enhanced current generation and new generation airborne radar to detect potentially hazardous engine icing conditions

Safety Driven Weather Requirements for Wake Mitigation

Develop an airport wind-based wake vortex separation advisory system

FY15 Accomplishments

- **CW** - OPC initial prototype completed; Expanded probabilistic convection forecast guidance prototype to global scale; added new NWP models (Canadian, European, Chinese) to existing US models for ensemble expansion; Identify potential opportunities & key shortfalls associated with improved airport operations lightning threat awareness
- **AWRT** - Implemented a new 2-D melting layer delineation scheme in the MRMS testbed - minimizes erroneous removal of precipitation pixels in the bright band area, improves icing detection; Completed implementation of Canadian radar quality control algorithms into MRMS
- **TRB** – GTG (MWT/all flight levels) transitioned to NWS (operational Oct '15); EDR forecast outputs labeled with subjective intensity categories; Users aircraft weight class (light, medium, heavy) /intensity for particular aircraft type; Hourly forecasts out to 18 hours
- **IFI** - Enhanced forecast & diagnosis CONUS algorithm (CIP/FIP HiRes) transitioned to NWS for operational implementation; Participated in NASA Glenn Winter Field Program to support development of forecast & diagnosis capability including LWC, drop size distribution, and temp (MICRO), & support development of Radar Icing Algorithm using NEXRAD Dual-Polarization
- **MDE** - RAP (v3) delivered to NOAA for 2016 implementation: Improvements to IFI & TRB; HRRR (v2) delivered to NOAA for 2016 implementation: Improvements to CW and C&V

FY15 Accomplishments (cont'd)

- **QA** - Assessments of TRB, IFI (AK), off-shore convection; satellite, aircraft & global observation data set research; R&D of metrics that measure forecast quality in context of aviation safety, capacity & efficiency
- **AWDE** – GTG (MWT/all flight levels) assessment; Participated as a remote site for NWS Summer Experiment; Convective Aviation Weather Statement (CAWS) Operations Demo at 5 FAA facilities in support of AJV and CDM
- **HIWC** - Field campaign, French Guiana to capture ice crystal environmental data; Field campaign, Florida to collect ice crystal environmental data & evaluate current on-board radar ability to detect HIWC environments
- **TAIWIN** – Analysis of wx capabilities for detecting/reporting terminal area icing, spatial & temporal variability of precipitation in the terminal area, icing-relevant fields in NWP models; Completed draft TAIWIN ConOps document
- **EDR** - Validated Mean EDR performance recommendation based on user requirements

Anticipated Research in FY16 and FY17

- **CW:** Determine lightning-induced ramp closure NAS impacts; Complete develop/evaluate of probabilistic convective 8-36 hour forecasts in oceanic regions; 0-8 hour CW model blending enhancements; Improve/evaluate OPC; Research/develop offshore 0-8 hour forecast capability
- **AWRT:** Integrate Caribbean radar networks into MRMS system; Integrate icing detection algorithms into the MRMS system; Integrate turbulence detection algorithm (NTDA) into the MRMS system
- **VA:** Enhance model output for HY-Split Model on forecasting volcanic ash
- **C&V (CONUS):** Enhance HEMS tool C&V analysis with NWS forecast grids and forecast guidance
- **C&V (Alaska):** Install experimental C&V Analysis for AK (CVA-AK) at AAWU; Evaluate CVA-AK performance
- **IFI:** Continue development of CONUS in-flight icing forecast and analysis capability algorithm that will include liquid water content, drop size distribution and temperature (MICRO), Use of research aircraft for verification and gathering of additional data; Complete development of the Alaska IFI Forecast and Diagnoses capability (Icing Product Alaska)
- **TRB:** Research into gravity wave parameterization of convectively induced turbulence; Continued research into requirements and potential solutions for probabilistic turbulence forecasts
- **MDE:** Improve analyses using new wx observation sources; Define detailed wx features by improving resolution
- **QA:** TRB, IFI-AK, Oceanic Convection, C&V assessments; on-going development & maintenance of verification tools & methodologies
- **AWDE:** Plan/Conduct OPC Assessment; Participate as satellite location in AWC Winter Experiment; CAWS Operational Suitability Assessment

Anticipated Research in FY16 and FY17 (cont'd)

- **Mitigating the Ice Crystal Wx Threat to Aircraft Turbine Engines:** Complete analysis of ice crystal data from flight campaigns and evaluate Part 33, Appendix D envelopes, assessing proposed changes if warranted
- **Terminal Area Icing Wx Information for NextGen:** Analyze current terminal area weather capabilities and NWP model capabilities for SLD diagnosis/forecasting. Initiate strategy and development of a TAIWIN capability
- **Validation of Performance Standards of in situ EDR algorithms:** Provide inputs to RTCA/DO-252A, Minimum operational performance standards for EDR
- **Using Data Linked Aircraft Sensed Weather Information to Determine Probability of Icing Conditions Aloft:** Determine feasibility of use of in-situ data for improvement of forecasts of icing-relevant parameters in NWP models
- **Validation of Advanced Airborne Radar Wx Hazards Detection:** Prepare for and conduct flight test of Airborne Wx Radar for detection of potentially hazardous engine icing crystal conditions

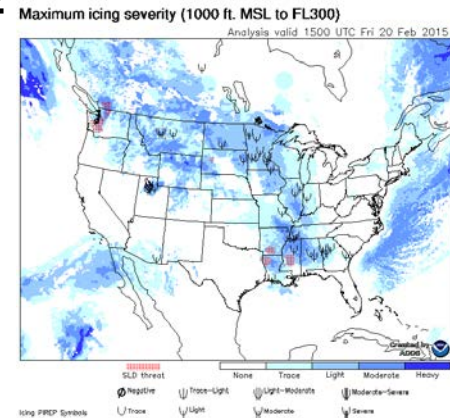
In-Flight Icing

Research Requirement

- Improve operationally-available, high-resolution, accurate diagnoses and probabilistic forecasts of aircraft icing conditions. Develop and implement forecasting, for less than and more than 1 hour, and modeling techniques that will improve icing guidance products for tactical and strategic avoidance.
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: Dino Rovito, ANG-C64, 202-267-2792

Outputs/Outcomes

- Nowcasts & 0-18 hr probabilistic forecasts including severity over the CONUS, Alaska and Global for operational use by ATM, dispatchers, and pilots to enhance capacity and safety.



In-Flight Icing Severity 1000 ft MSL – FL300

FY 2018 Plans

- Transition CONUS in-flight icing forecast and analysis capability, that includes liquid water content, drop-size distribution, and temperature, for implementation

Out Year Funding Requirements

FY16	FY17	FY18
\$1.1 M	\$1.4 M	\$1.4 M

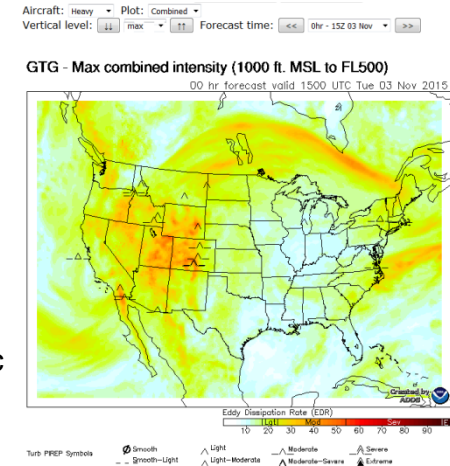
Turbulence

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 Farrar, ANG-C64, 202-267-27963

Outputs/Outcomes

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



FY 2018 Plans

- Transition Alaska turbulence forecast capability to NWS for operational implementation
- Commence research and development of satellite-based turbulence feature detectors

Out Year Funding Requirements

FY16	FY17	FY18
\$1.1M	\$1.1M	\$1.0M

Convective Weather

Research Requirement

- Improve observations and forecasts of convective weather and create and improve standards and techniques for weather DSTs 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 products and DSTs that meet users' requirements and are applicable to their needs
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: Randy Bass, ANG-C61, 202-267-2800

Outputs/Outcomes

- Offshore Precipitation Capability: 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
- Oceanic Convection: Probabilistic convection guidance with lead times from 0 to 36 hours used for current operations and strategic planning of transoceanic flights
- Lightning: Determine impacts to the NAS from ramp closures due to lightning; Standardized but tailorable guidelines for ramp closure implementation due to lightning, improve safety of personnel and gain efficiencies in terminal operations

FY 2018 Plans

- Develop blending techniques for CIWS & CoSPA to improve storm location, timing and intensity accuracy during transition from extrapolated to model forecast transition in the 1-4 hour period
- Integrate new satellite data into research and operational weather products
- Develop, test, and integrate forecast confidence and other uncertainty measures into weather models and other CW forecasts

Out Year Funding Requirements

FY16	FY17	FY18
\$1.7M	\$1.7M	\$1.7M

Ceiling and Visibility (C&V)

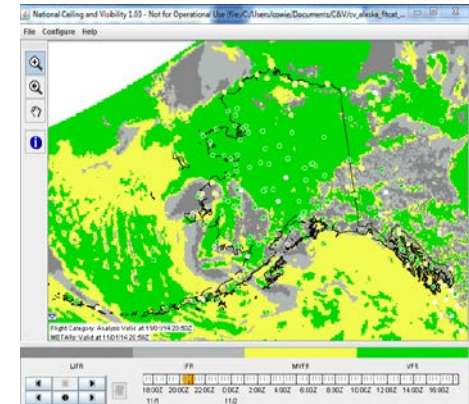
Research Requirement

- 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 production; production of automated TAFs in areas where no TAF exists; Improvements to the accuracy & resolution of AIRMETs; Improvements to forecasts in TRACON areas; Updates to the C&V analysis of HEMS tool
- Done in collaboration with NWS to improve products and services the FAA requires
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: Jenny Colavito, ANG-C62, 202-267-2787

Outputs/Outcomes

Products:

- Improvements to C&V analysis in Helicopter Emergency Medical Services (HEMS) tool
- Improve NAS analysis and forecast guidance products
- C&V Analysis for Alaska (CVA-AK)



Example of a gridded C&V analysis product for Alaska.

FY 2018 Plans

- Ceiling and Visibility (CONUS): Evaluate use of C&V critical threshold probabilities derived from ensemble forecasts
- Ceiling and Visibility (AK): Adapt existing image processing technology to estimate the visibility at a sub-set of FAA Alaskan weather cameras and blend the results into the Experimental CVA-AK to provide more accurate real-time depictions of visibility conditions.

Out Year Funding Requirements

FY16	FY17	FY18
\$ 740K	\$ 740K	\$ 740K

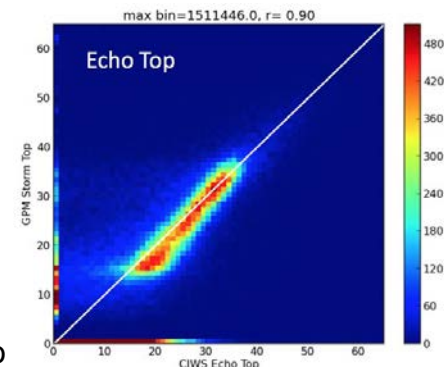
Quality Assessment (QA)

Research Requirement

- Improved observations & enhanced forecasts; Effective & reliable verification of weather products prior to becoming operational is essential in ensuring the accuracy, performance, and value of these products for NAS users
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC Danny Sims, ANG-C61, 202-267-2785

Outputs/Outcomes

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



FY 2018 Plans

- Quality assessments of weather research products including: advanced icing, turbulence, convective, and oceanic research capabilities; maintenance and research of verification tools and methodologies

Out Year Funding Requirements

FY16	FY17	FY18
\$ 1.5M	\$1.5M	\$1.5M

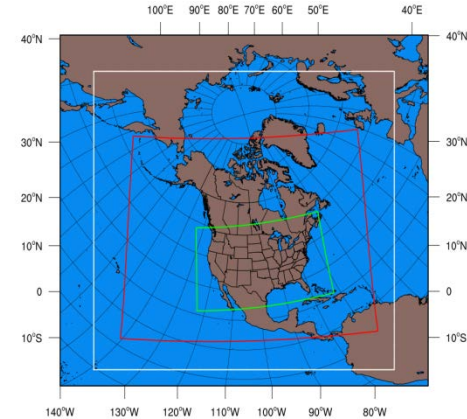
Model Development and Enhancement

Research Requirement

- Enhanced aviation specific weather hazard diagnosis and forecast information; Improve operationally available model resolution and refresh rates to enhance nowcasts and forecasts of aviation hazards including in-flight icing, turbulence, convective storms, and ceiling & visibility
- Sponsored by ANG-C6, ANG-C7, AJV, AJR, AJM
- POC: Danny Sims, ANG-C61, 202-267-2785

Outputs/Outcomes

- 0-24 hour high resolution rapid refresh with increased domain to include oceanic airspace to support aviation forecast products; global model with hourly output compatible with suite of NOAA models – enhanced NAS safety and capacity/efficiency from improved forecasts of aviation specific weather hazards



FY 2018 Plans

- Transition North American rapid refresh ensemble weather forecast model (13km) to the NWS for operational implementation
- Commence development of ensemble forecasts for probabilities and uncertainty
- Commence development of global forecast capabilities

Out Year Funding Requirements

FY16	FY17	FY18
\$ 1.4M	\$1.5M	\$1.5M

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 Starr McGettigan, ANG-C63; 609-485-5936

Outputs/Outcomes



Enhanced demonstration and evaluation services with subject matter expertise, improved data resources including live aircraft situation data, and metrics capability.

FY 2018 Plans

- Complete suitability assessment of an advanced convective weather forecast product
- Enhance operational impact metric capabilities

Out Year Funding Requirements

FY16	FY17	FY18
\$ 550K	\$525K	\$525

Mitigating the Ice Crystal Wx Threat to Aircraft Turbine Engines

Research Requirement

- NTSB: A-96-54, -56, & -58
- Characterization of High Ice Water Content (HIWC) ice crystal environments that can be a threat to turbine engines
- Diagnosis and forecasting of HIWC ice crystal environments
- Sponsored by AFS-200
- POC Jim Riley, ANG-E2; 609-485-4144

Outputs/Outcomes

- Outcome supported: Atmospheric HIWC ice crystal data set sufficient for assessment of certification envelopes, development of test facilities, and diagnosis and forecasting for avoidance
- Benefits resulting: Significant reduction in threat to current and future designs

FY 2018 Plans

- Plan for and possibly conduct additional ice crystal icing field campaign and ice crystal weather radar field testing

Out Year Funding Requirements

FY16	FY17	FY18
\$ 400K	\$ 1.0M	\$ 1.0M

Terminal Area Icing Wx Information for NextGen

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 SLD rule on terminal area operations; research on automated reporting systems and improved weather diagnostic/forecast tools
- Sponsored by: ANE-100, ANM-100
- POC Jim Riley, ANG-E2; 609-485-4144

Outputs/Outcomes

- Outcome supported: Improved icing weather information including SLD in terminal area
- Benefits resulting: 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 2018 Plans

- Develop and complete report on the initial TAIWIN implementation capabilities

Out Year Funding Requirements

FY16	FY17	FY18
\$ 1.4M	\$ 1.1M	\$ 1.5M

Other Core Wx Program FY18 Efforts

- **AWRT** – Multi-Radar/Multi-Sensor (MRMS) research: to improve real-time detection of in-flight hazards using high-res, high quality, 3D weather radar data analysis from national & international radar networks; also support NWS operational capability. MRMS capability will also function as a validation tool for high-resolution forecasts & decision support tools. FY18 – integrate CW & lightning data algorithms; integrate Pacific radar networks
- **Volcanic Ash** - Enhancement and global harmonization of ash transport and dispersion forecast models; FY18 – complete prototype on-line model verification database; include reverse modeling capabilities & confidence levels into ash density model forecasts
- **Application of Uncertainty in ATM Wx Decisions** – Development of weather uncertainty information requirements; FY18 – improve guidance and initial requirements for providers of weather info including uncertainty to the FAA, most likely the NWS; guidance for FAA systems such as NWP for most effective/impactful wx info containing uncertainty

Acronyms

- AAWU - Alaskan Aviation Weather Unit
- AK - Alaska
- CIP/FIP – Current Icing Product/Forecast Icing Product
- DSTs – Decision Support Tools
- EDR – Eddy Dissipation Rate
- FLs – Flight Levels
- GTG – Graphical Turbulence Guidance
- HEMS - Helicopter Emergency Medical Services
- HiRes – High Resolution
- HRRR – High Resolution Rapid Refresh
- LWC – Liquid Water Content
- MICRO - Model of Icing Conditions for Real-Time Operations
- MRMS - Multi-Radar, Multi-Sensor
- MWT – Mountain Wave Turbulence
- NTDA - NEXRAD Turbulence Detection Algorithm
- NWP - Numerical Weather Prediction
- NWS - National Weather Service
- OPC – Offshore Precipitation Capability
- RAP – Rapid Refresh
- SLD – Supercooled Large Droplet
- Wx - Weather