The Federal Aviation Administration’s Advanced Weather Radar Techniques Program

Presented to: Sixth Conference on Transition of Research to Operations

By: Randy Bass
Aviation Weather Research Program
FAA / Aviation Weather Division

Date: 14 January 2016

With significant contributions from Courtney Maciejewski (FAA)
Aviation Weather Research Program (AWRP)

- Applied research to minimize the impact of weather on the National Airspace System (NAS) by:
  - Meeting specific NextGen Operational Improvements in NextGen Implementation Plans
  - Mitigating weather related safety and/or efficiency issues with a line of sight to operations
  - Evolving weather information required today in legacy capabilities to meet emerging NextGen needs often in collaboration with the National Weather Service (NWS)
Advanced Weather Radar Techniques

Project History & Overview:

- The Advanced Weather Radar Techniques (AWRT) Product Development Team (PDT) was established by the AWRP for the research and development (R&D) of advanced radar technologies for aviation weather applications.
- AWRT explores quality control techniques to mitigate effects of any conditions which may result in false weather radar presentations.
- The work involves applications using the newly-fielded dual polarization capabilities and the integration of multiple radar assets (WSR-88D, Terminal Doppler Weather Radar (TDWR), Canrad). The mosaic applications reside in the Multi-Radar Multi-Sensor (MRMS) system.
Advanced Weather Radar Techniques

Mission:
- Improve and increase radar detection and forecast of aviation-impacting weather conditions, and enhance the delivery of aviation weather services by the FAA and the NWS

Goals:
- Research and develop quality assurance schemes for MRMS data, and develop new products based on requirements from the operational aviation community
- Provide evaluation of existing weather radar sensors and processor networks
- Support roadmap investment decisions and initial concepts of weather radar sensing and data processing
Advanced Weather Radar Techniques

- The FAA’s William J Hughes Technical Center (WJHTC) operates a MRMS R&D system for testing and development of aviation-weather related capabilities
- This test bed is compatible with the R&D MRMS system at National Severe Storms Lab (NSSL) and the operational MRMS system at the National Center for Environmental Prediction (NCEP)
- Available with a 30 second product update cycle supporting the FAA’s Common Support System – Weather (CSS-Wx) capability evaluations
- Actively utilized in data assimilation, product development, and as a verification tool for new FAA and NWS algorithms and products such as icing and turbulence detection
- Internal FAA MRMS website with user defined archives for significant weather cases
- New operational products available for use by FAA, airlines, aviation meteorologists and other users
Multi-Radar Multi-Sensor (MRMS)

“A Powerful 3D Weather Radar Capability”

- Decision Support Tool Validation
- Requirements Identification
- Modeling & Simulation
- Concept Validation

Image descriptions:
- Left: Map of the United States with weather data overlays.
- Right: 3D weather radar simulation with data points.
MRMS Domain

- 1 km resolution
- 30 sec update cycle

- **WSR-88D**
- **Canadian**
- **TDWR**
Integrated multiple sensor approach to high resolution rendering of storms and weather

Composite Reflectivity
Derived From Mosaic3D

Valid At:
05/31/2008 12:00:00 UTC

Terrain Background [x100m]
Reflectivity [dBZ]

6 8 10 12 15 20 25 30 35
10 15 20 25 30 35 40 45 50 55 60 65 70 75
90.00W 46.00N 72.91W 38.00N

Lightning
Radar Networks
Upper Air
Satellite
Models
Sfc Obs
Precipitation Flag
Derived From Mosaic3D

Valid At:
06/06/2010 03:20:00 UTC

Precipitation Type and Quality:
- No File
- Missing
- No Precip
- Snow
- Stratiform
- Convective
- Warm Rain
- Overshooting
- Brightband
- Hail

Lightning
Radar Networks
Upper Air
Satellite
Models
Sfc Obs

Sixth Conference on Transition of Research to Operations

Federal Aviation Administration
Surface Precip Classification Validation

mPING.nssl.noaa.gov
MRMS Science-2-Operations Transfer

The NextGen research and development work flow

- WSR-88Ds
- Canadian Radars
- Atmospheric Environmental Data
- TDWRs
- Gap-filler Radars
- Add’l Radars

MRMS@NSSL
(Research System)
AWRP PDTs R&D

MRMS@WJHTC
(Prototype System)

New techniques & products
New requirements

MRMS@ NWS
(Operational System)

FAA/AWC/
CWSU/FOs

New requirements
New tech & products

To operations
Feedback
Recent Accomplishments

- Development, testing and verification at WJHTC was instrumental in transitioning MRMS to operational status at NCEP in September 2014
- 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
Current and Planned Projects

Tasks and expected accomplishments this coming year:

- Baseline the MRMS systems running at WJHTC, NSSL, and NCEP
  - Allows for a common operating system between the three locations
- Integrate Caribbean radar data
  - Improves the spatial coverage of MRMS to offshore areas in the Caribbean
  - Sets the process for additional MRMS suites for the Pacific to aid in aviation weather support
- Develop and integrate a Quasi-Vertical Profiles (QVPs) algorithm in MRMS
  - More precise identification of layers in the atmosphere where threats such as icing, high-ice water content hydrometeors, and dust exist
- Create and integrate icing and hydrometeor classification algorithms into MRMS
  - Improves diagnosis and depiction of icing conditions of interest to aircraft operations
- Complete a feasibility study for the potential implementation of NCAR’s Turbulence Detection Algorithm (NTDA) and the Diagnosis of Convectively-Induced Turbulence (DCIT) algorithm into the MRMS system
  - Risk reduction task to identify benefits and risks (including operational considerations), path to operations, and steps required to bring these capabilities into operation
- Develop a 5 year plan for aviation-weather related algorithm development and potential integration of MRMS system and/or products into FAA operations
New Radar Additions

- FY16 work to configure and implement new MRMS domains (in red)
  - Cuba
  - Bahamas
  - Jamaica
  - Cayman Islands
Summary

- AWRT manages R&D of advanced radar technologies for aviation weather applications and explores quality control techniques to mitigate effects of conditions which may result in false weather radar presentations.
- The FAA operates a MRMS R&D system for testing and development of aviation-weather related capabilities.
- Actively utilized in data assimilation, product development, and as a verification tool.
- Test bed is compatible with the R&D MRMS system at NSSL and the operational MRMS system at NCEP.
- Established, working process for transition of MRMS algorithms from research to operations.
- Good collaborative working relationship with NSSL, the National Center for Atmospheric Research and others for improving MRMS capabilities.
Questions?

Contact information:

**Randy Bass**
Certified Consulting Meteorologist
Aviation Weather Research Program
Federal Aviation Administration
Washington, DC
202-267-2800
randy.bass@faa.gov

**Courtney Maciejewski**
Basic Commerce & Industries
FAA William J. Hughes Technical Center
Atlantic City Int'l Airport
609-485-8396
courtney.CTR.maciejewski@faa.gov
Back Up
Convective Weather in FliteViz 4D Visualization Tool

- The FAA Concept Analysis Branch developed an interactive four-dimensional (4D) visualization tool for analysis of practically any aviation concept.

- This tool overlays 3D MRMS products with real aviation traffic to examine flight deviations while encountering weather events.
MRMS Transition into NCEP Operations

- MRMS has been installed on the NWS Integrated Dissemination Program (IDP) Phase II processing farm at NCEP in College Park, MD
- Initial MRMS configuration product suite operational in Sept 2014
- Major MRMS product updates Sept 2015 and July 2016
- MRMS full backup system located on the NWS IDP processing farm in Boulder, CO (March 2015)