Multi-Radar Multi-Sensor (MRMS) System – What is…?

“….a cast of thousands…”

NSSL
CIMMS
ROC
NCO
NWS
FAA
DoD
CWB
What is MRMS?

An NWS *operational* system for the integration of multi-sensor data and creation of high-resolution (1km, 2min) severe weather, aviation, model data assimilation and precipitation products over CONUS and southern Canada.
MRMS Dataflow

- **CONUS Domain:** 20-55°N, 130-60°W
- **Resolution**
  - 0.01° latitude x 0.01° longitude
  - 2 min update cycle
- **Data Sources**
  - ~180 radars every 4-5min
    - WSR-88Ds L3, L2
    - Canadian L2
    - TDWR ‘base’
    - Gap filling
  - ~10000 gauges every hour
    - HADS
    - MADIS
  - RAP/HRRR hourly analyses
  - Lightning and satellite
MRMS in Operations

- MRMS completed transition to operations (Initial Operational Capability-V10.0) on Sep. 29, 2014
- Runs on Integrated Dissemination Program (IDP) Processing Infrastructure in College Park, MD and Boulder, CO.
  - Consists of ~55 virtual machines
  - C++ Code Environment
  - 6-month code release cycle
  - Backup IDP System located in Boulder, CO
- Most recent version implemented is V10.5
  - Operational December 2015
  - Includes RIDGE II requirements and additional oCONUS domains
  - Current onboarding MRMS v11.0 (5-km CREF and NCAR ANC)
- Generates over 155 unique product files every two minutes
  - Up to 200 GB/day
MRMS Product Description

Welcome to the NEW AMS Journals site!

Abstract
The MRMS system’s initial operating capabilities for severe weather and aviation include quality-controlled, multi-radar fields of three-dimensional reflectivity, near-snow environment, and radial velocity derivatives to produce severe weather guidance information.

The Multi-Radar Multi-Sensor (MRMS) system, which was developed at the National Severe Storms Laboratory and University of Oklahoma, was made operational in 2014 at the National Centers for Environmental Prediction. The MRMS system consists of the Warming Decision Support System—Integrated Information suite of severe weather and aviation products, and the quantitative precipitation estimation products created by the National Mosaic and Multi-sensor Quantitative Precipitation Estimation system. Products created by the MRMS system are at a spatial resolution of approximately 1 km, with 33 vertical levels, updating every 2 minutes over the Contiguous United States and southern Canada. This paper describes initial operating capabilities for the severe weather and aviation products that include a three-dimensional mosaic of reflectivity, guidance for hail, tornado, and lightning hazards, and nowcast of storm location, height and intensity.

Corresponding Author Address: Travis Smith, NSSL/WRD. National Weather Center, 120 David L. Boren Blvd., Norman, OK, 73072. Email: Triviss.Smith@noaa.gov

Abstract
The MRMS QPE initial operating capabilities include an ensemble of quantitative precipitation estimations and associated diagnostic products based on radar, gauge and atmospheric environmental and climatological data at 1-km resolution and 2-min update cycle over CONUS.

Rapid advancements of computer technologies in recent years made the real-time transferring and integration of high-volume, multi-source data at a centralized location a possibility. The Multi-Radar Multi-Sensor (MRMS) system recently implemented at the National Center for Environmental Prediction demonstrates such capabilities by integrating ~180 operational weather radars from contiguous United States and Canada into a seamless national 3-D radar mosaic with very high spatial (1 km) and temporal (2 min) resolution. The radar data can be integrated with high-resolution numerical weather prediction model data, satellite data, lighting and radar observations to generate a suite of severe weather and quantitative precipitation estimation (QPE) products.

Corresponding author address: Jar Zhang, NSSL, National Weather Center, 120 David L. Boren Blvd., Norman, OK, 73072. Email: jae.zhang@noaa.gov
MRMS Product Dissemination

NOAAPORT Dissemination:
- YAUC01 Composite Reflectivity
- YAUC02 Composite Reflectivity Height
- YAUC03 Composite Reflectivity [0-4 km]
- YAUD01 Radar Quality Index
- YAUD02 Seamless Hybrid Scan Reflectivity
- YAUL01 Cloud-to-Ground Lightning Probability (0-30 min.)
- YAUL02 Cloud-to-Ground Lightning Density (1, 5, 15, & 30 min.)
- YAUM03 Probability of Warm Rain (POWR)
- YAUP01 Surface Precipitation Type
- YAUP02 Instantaneous Radar Precipitation Rate
- YAUP03 Radar 1H, 3H, 6H, 12H, 24H, 48H, 72H QPE
- YAUP04 Local Gauge Bias Corrected 1H, 3H, 6H, 12H, 24H QPE
- YAUP06 Mountain Mapper 1H, 3H, 6H, 12H, 24H, 48H, 72H QPE
- YAUQ01 Base Reflectivity
- YAUS04 Low-Level Rotation Tracks (60 & 1440 min. accum.)
- YAUS06 Mid-Level Rotation Tracks (60 & 1440 min. accum.)
- YAUS10 Maximum Estimated Size of Hail (MESH)
- YAUS11 MESH Tracks (60 & 1440 min. accum.)
- YAUS13 Vertically Integrated Liquid (VIL)
- YAUS15 Vertically Integrated Ice (VII)
- YAUS16 18, 30, 50, & 60 dBZ Echo Top (ET)
- YAUS17 Height of 50dBZ Echo Above -20°C
- YAUS18 Height of 50dBZ Echo Above 0°C
- YAUS20 Height of 60dBZ Echo Above 0°C
- YAUS21 Reflectivity at 0°C, -10°C, -20°C
- YAUS22 Reflectivity At Lowest Altitude (RALA)

NCO LDM Dissemination:
(all MRMS products)
MRMS Transparency

MULTI-RADAR/MULTI-SENSOR SYSTEM (MRMS)

MRMS Transition to Operations

GRIB2 IOs for MRMS Data

RELATED LINKS

- MRMS Fact Sheet (PDF)
- MRMS Application Suite
- GRIB2 IOs for MRMS Data
- MRMS Virtual Lab (user account required)
- MRMS News
- WQSS-II
- NSSL On-Demand

CURRENT WORK:

- Advanced CONUS 4D reflectivity mosaic and products
- Severe weather and aviation related products per FAA NextGen requirements
- Resolution of 1-km x 2-min update cycle with 3D reflectivity mosaic at 31 levels
MRMS Evaluation and Validation

Web-based evaluation tool: CONUS, 24/7

mrms.ou.edu:

- 2-D product images
- Cross sections of 3D refl grid
- QPE/gauge scatterplots and stats
- Time series of any MRMS variables at any point in CONUS
- Monitoring of radar calibrations
- etc.

NWS users have provided invaluable feedback that guided MRMS development to what it is today (Operations-2-Research).
MRMS R&D Platform

A *research* platform for evaluations of *new radar techniques* for severe weather, aviation, and hydrological applications and to facilitate their rapid *transition into operations*.

New radar techniques are developed based on *specific data*.

New techniques are *evaluated* and *refined* using 2-yr archived data across *CONUS*.

Matured techniques are evaluated on *CONUS* in *real-time*.

New techniques are transitioned into operations.
MRMS as a Real-Time National Radar Network Evaluation Tool

- Z calibration monitoring (completed ~2011)
- Real-time PPS and DPR radar QPE parameters monitoring (2014)
- Z_{DR} calibration monitoring (2015 – 2016)
  - Rain method
  - Snow method
  - Bragg scatter method
MRMS as a National Product System

- MRMS Dual-Pol radar QPE (2016-2018)
  - R(A), R(Kdp), R(Z) synthetic
- 3-D national $Z_{DR}$, $K_{DP}$, $\rho_{hv}$ mosaic (2016-2018)
- National Quasi Vertical Profile (2016-2018)
- All season surface precipitation type (2017-2019)
- Multi-Sensor Merged QPE (2017-2020)
  - Radar, satellite, gauge, model
- Turbulence (with NCAR, 2017-2020)
- 3-D national hydromet type and content (2018-2021)
- Icing (with NCAR, 2018-2021)
MRMS to Support Operational ORPG Product Generation

- Real-time DPR snow QPE coefficient estimator (2016)
- Real-time continental/tropical rain classification for $R(Z-Z_{DR})$ relationship selection guidance (2016)
MRMS as a National Testbed for Potential ORPG Products

- Specific attenuation based radar QPE [R(A)] (2015-2017)
- HCA2 (all season surface precipitation type) (2017-2019)
- Cloud detection (2018-2020)
- $Z_{DR}$ column (2018-2020)
MRMS Full Operating Capability (FOC)

- Full Operating Capability (FOC) will occur in Q2FY17- V12.0
  - Expansion to full suite of MRMS products including
    - Convective forecasts
    - Advanced hydro products for FFMP
    - Additional severe and aviation weather products
  - Fully redundant backup system in Boulder, CO
  - Full Optimization across all components of MRMS system
  - Upgrade the oCONUS RIDGE domains to run all V11.0 MRMS products
MRMS Radar QPE Processes

- Radar Data QC
- Blockage Mitigation
- Vertical Profile of Reflectivity (VPR) Correction
- Seamless Hybrid Scan Reflectivity (SHSR) Mosaic
- Surface Precipitation Classification
- Dynamic Z-R Relationships

Single radar, multi-sensor

Multi-radar, multi-sensor
Summary

- The Multi-Radar Multi-Sensor system provides high-resolution (1km, 2min) operational products for the CONUS and southern Canada.

- MRMS is a research platform for evaluations of new radar techniques and facilitates research-to-operations transfer of the new techniques.
Thank You!

MRMS - NSSL DEV
Multi-Radar Multi-Sensor System

Welcome to the Web Application Launcher
for Investigating the MRMS/Q3 System

Near the top of this page there is a horizontal row of tabs or buttons

- Hover over each button for a brief explanation of that item
- Click on the button to open that web application in a new browser window

mrms.ou.edu
Kenneth.howard@noaa.gov