



Multi-Radar/Multi-Sensor – Transition to Operations

Kenneth W Howard (NSSL/WRDD/SHMET)
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National Weather Center
Norman, Oklahoma





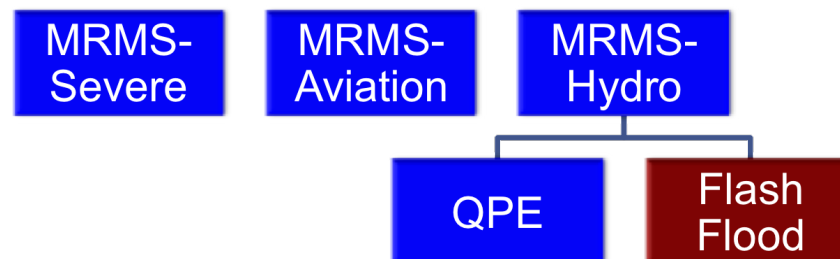
What is Multi-Radar/Multi-Sensor (MRMS)

a research and operational system for the integration and assimilation of multiple sensor observations and numerical analysis/prediction fields for the identification and short term prediction of hazardous weather.

Approaching **500,000** lines of code and scripts

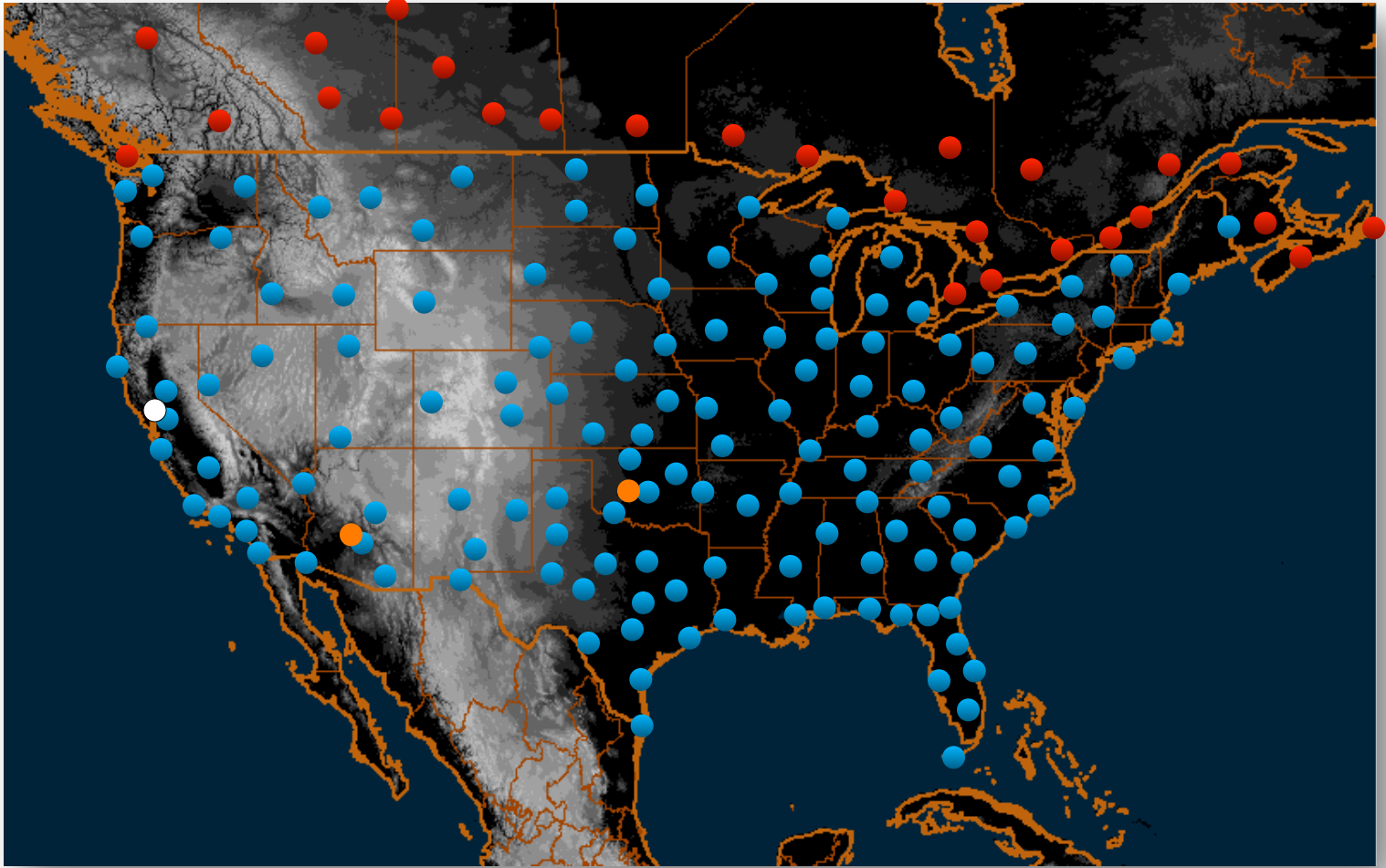
Generates **1,600 CONUS** product grids and data sets per day

80% of the MRMS products have never been operationally available






MRMS Domain

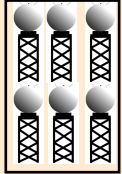



- ~140 WSR-88D
- 31 Canadian
- 19 TDWR
- 1 TV station radar

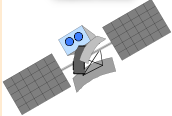


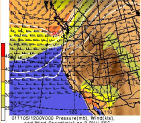
Integrated multiple sensor approach to high resolution rendering of storms and weather

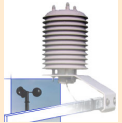
Lightning


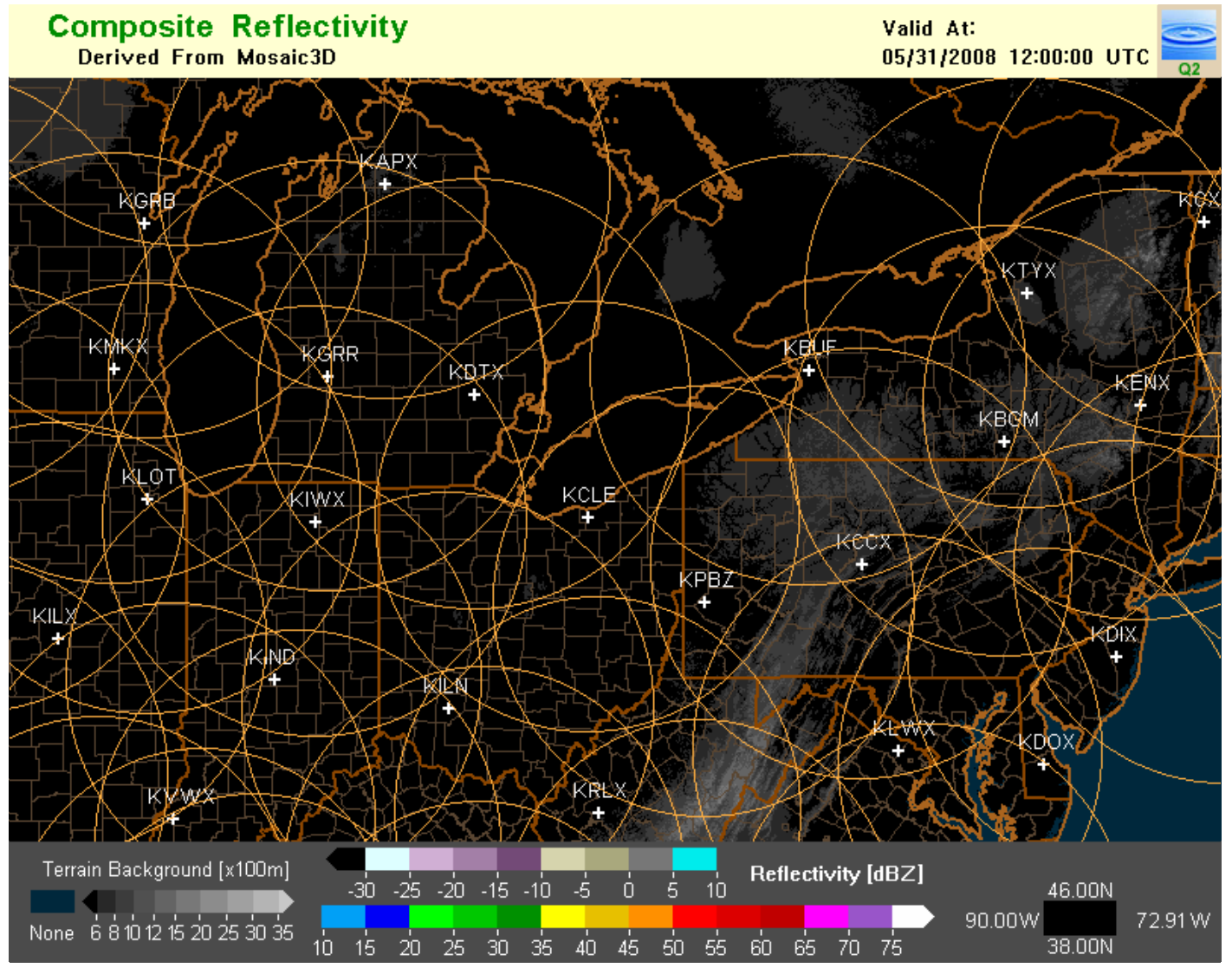
Radar Networks


Upper Air


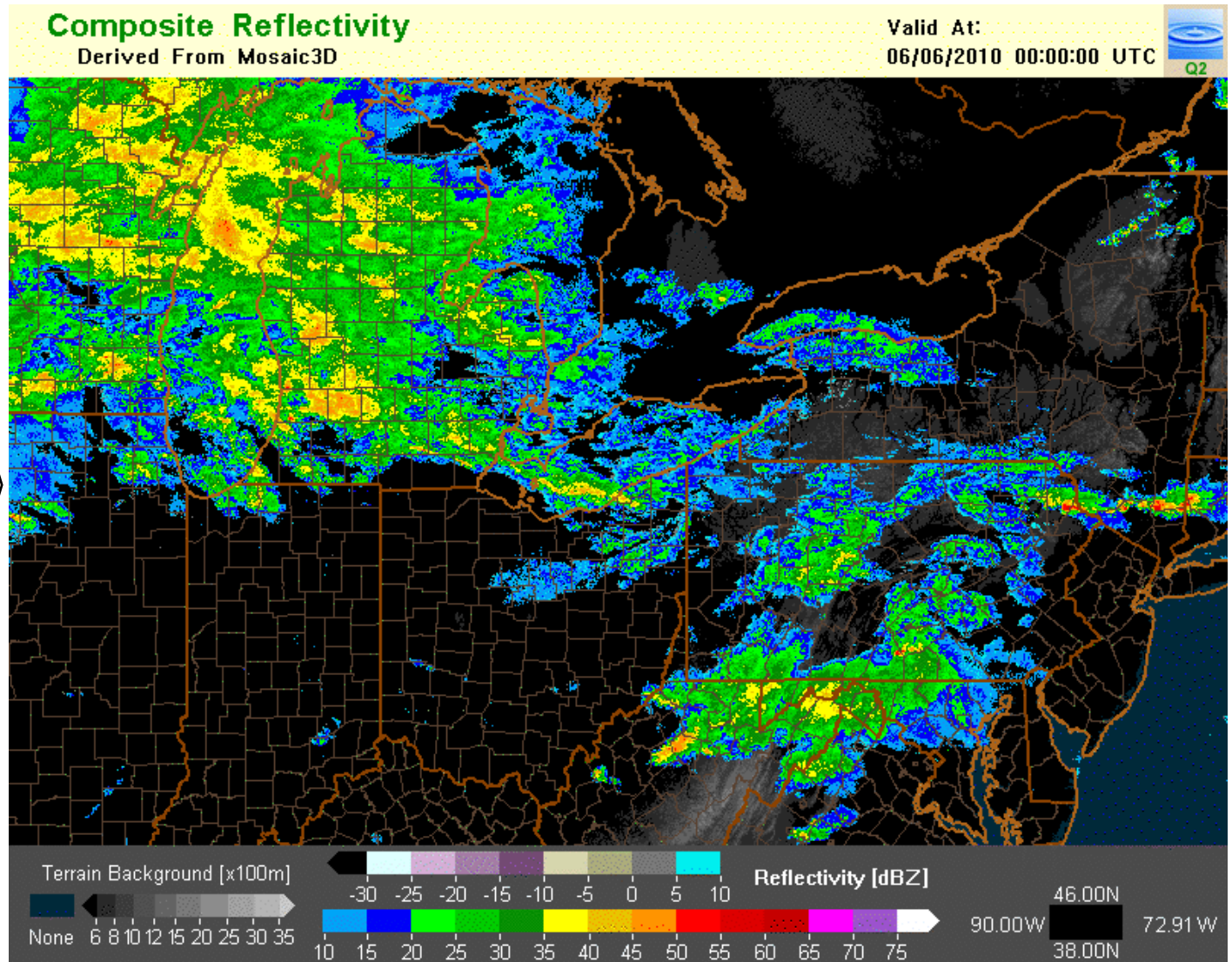
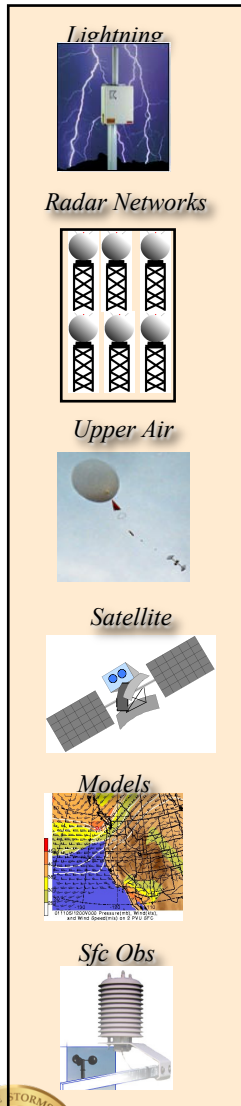
Satellite


Models


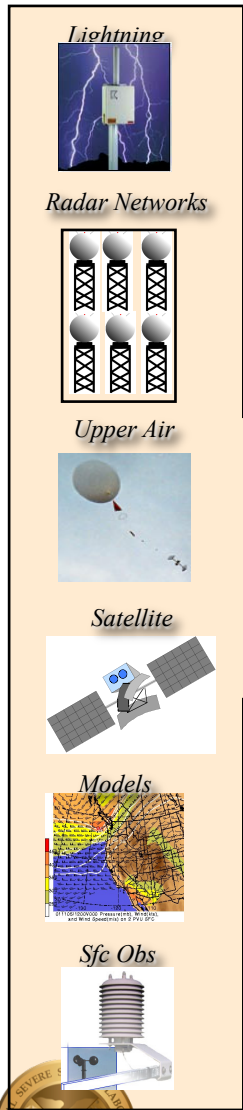
Sfc Obs




Integrated multiple sensor approach to high resolution rendering of storms and weather



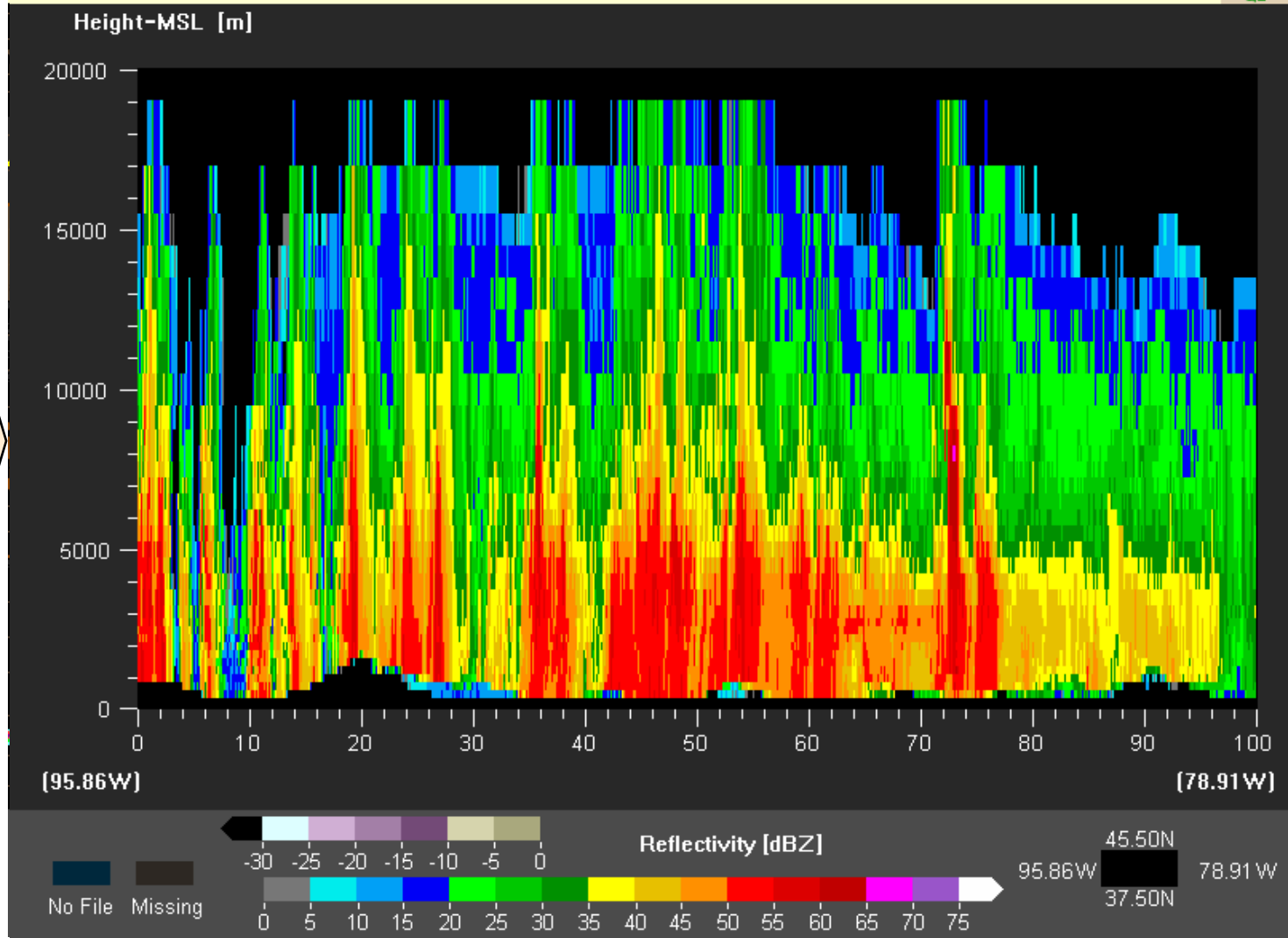
Integrated multiple sensor approach to high resolution rendering of storms and weather



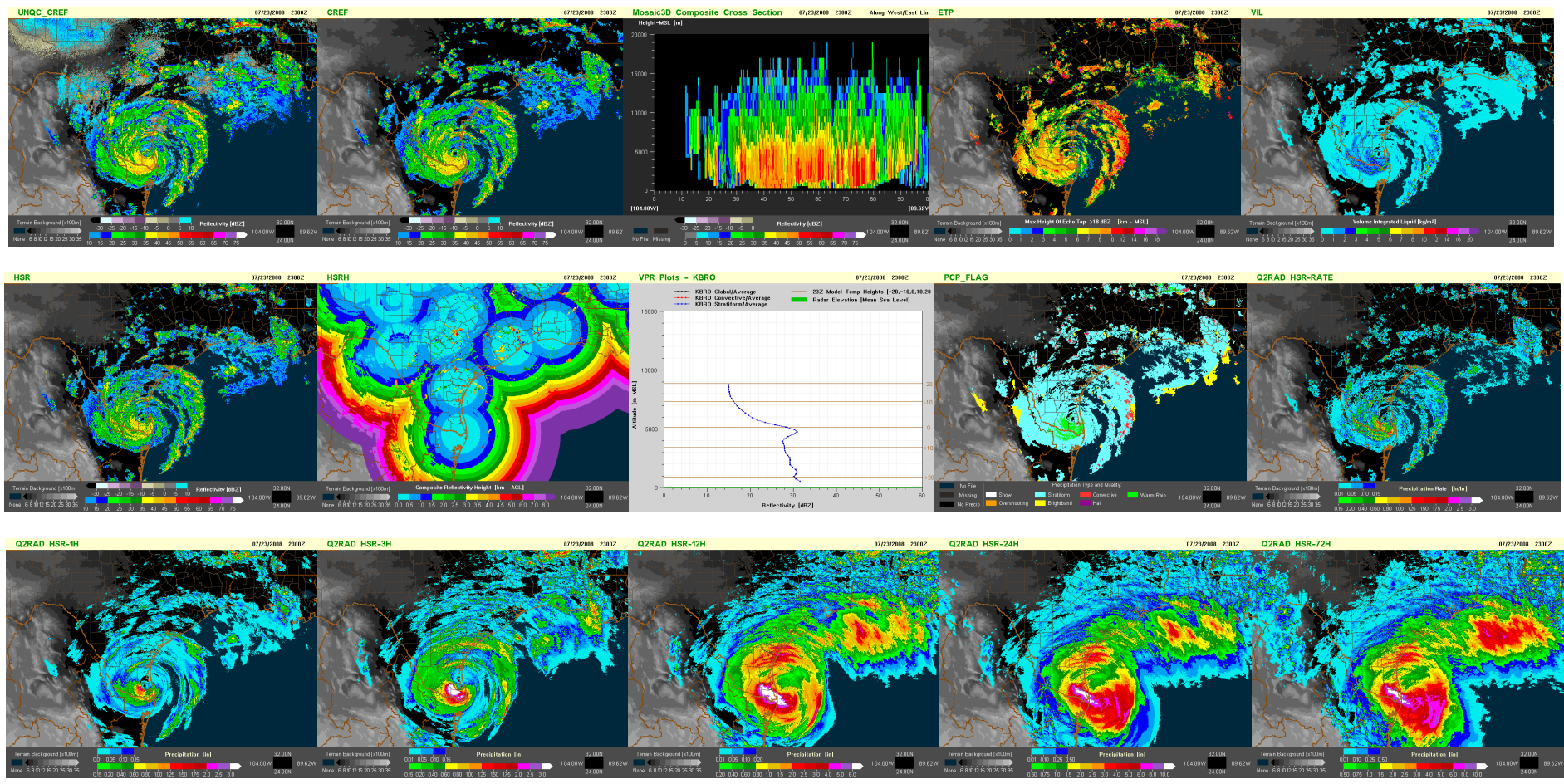
Mosaic3D Reflectivity

Vertical Cross Section - Composite Along West-East Line

Valid At: long West/East
06/06/2010 03:20:00 UTC



MRMS Reflectivity, Precipitation & Diagnostic Grids



MRMS produces and disseminates a suite of **100+** high resolution product grids over North America (**1-km, 2 to 5 minutes**) for use in model data assimilation, severe weather, aviation and hydrometeorology (flooding and water resource management).



Transparency - MRMS Web Portals

NATIONAL MOSAIC & MULTI-SENSOR QPE (NMQ)
Advancing the science and science-to-operations of QPE and very short-range QPF

| Home | Inventory | Mosaic3D Levels | Mosaic3D Derived | VPR | RUC |
|------|-----------|-----------------|------------------|-------------|-------------|
| QPE | QPF | Gauge | Satellite | Diagnostics | Time Series |

National Mosaic and QPE (NMQ)
[NSSL Main Page](#)
[NMQ Tutorial](#)

The NMQ project is a joint initiative between the National Severe Storms Laboratory, Federal Aviation Administration, National Weather Service/Office of Hydrologic Development, the Office of Climate, Water and Weather Services and the University of Oklahoma Cooperative Institute in Mesoscale Meteorological Studies.

The NMQ serves as an international testbed for research, development, evaluation and science to operations infusion of high resolution 3D Mosaic of multiple radars and radar networks for model assimilation and aviation applications, Quantitative Precipitation Information (QPI) including Multiple Sensor Quantitative Precipitation Estimation (MSQPE) and Very Short Term Quantitative Precipitation Forecasts (VSTQPF) for the monitoring and warnings of floods and flash floods and in support of comprehensive hydrology and ecosystem modeling.

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mrms.ou.edu

WDSS-II The Warning Decision Support System - Integrated Information
Experimental Real-Time Severe Weather Applications

Home Real Time WDSS-II Data

Products Welcome to WDSS-II

Archive We have available a collection of experimental weather products for use with any Geo-Browser.

Web Images These data are available in two formats: **Accessing WDSS-II Data**

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Notice: It is normal for this experimental data feed to experience temporary outages.

Visit wdssii.org for more information.

Please use the menu on the left to select products.

Examples of WDSS-II products

About WDSS-II Products
 The radar images are updated every 5 minutes (2 minutes for velocity products), and have 1km grid resolution. Data are merged from WSR-88D radars across the continental United States. **New (March 2009): This site now uses tiled PNG images, and works best with Google Earth 5 (or later).**

NWS Warning polygons are updated every minute, while storm report maps are updated hourly.

Scientific Background Information

CONUS-scale radar reflectivity

Hail Swath of maximum hail size

Rotation Tracks of mesocyclones

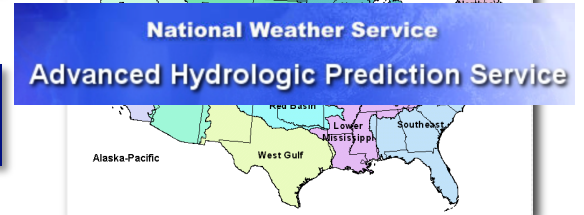
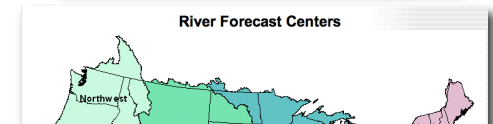
These pages have been designed and maintained by **SWAT** and **RADD** Teams at NSSL and the University of Oklahoma.

Disclaimer: Use at your own risk. Data are experimental and may experience any number of problems including being late or not being available at all. Do **not** use for protection of life or property, or for any commercial use without permission.

wdssii.nssl.noaa.gov



MRMS Collaborators and Product Distribution



Environment Canada

Environnement Canada

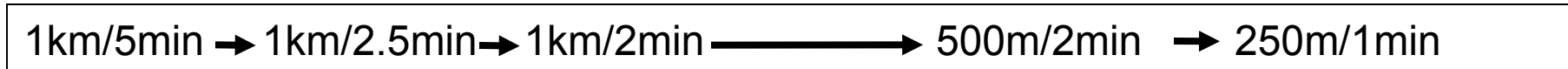
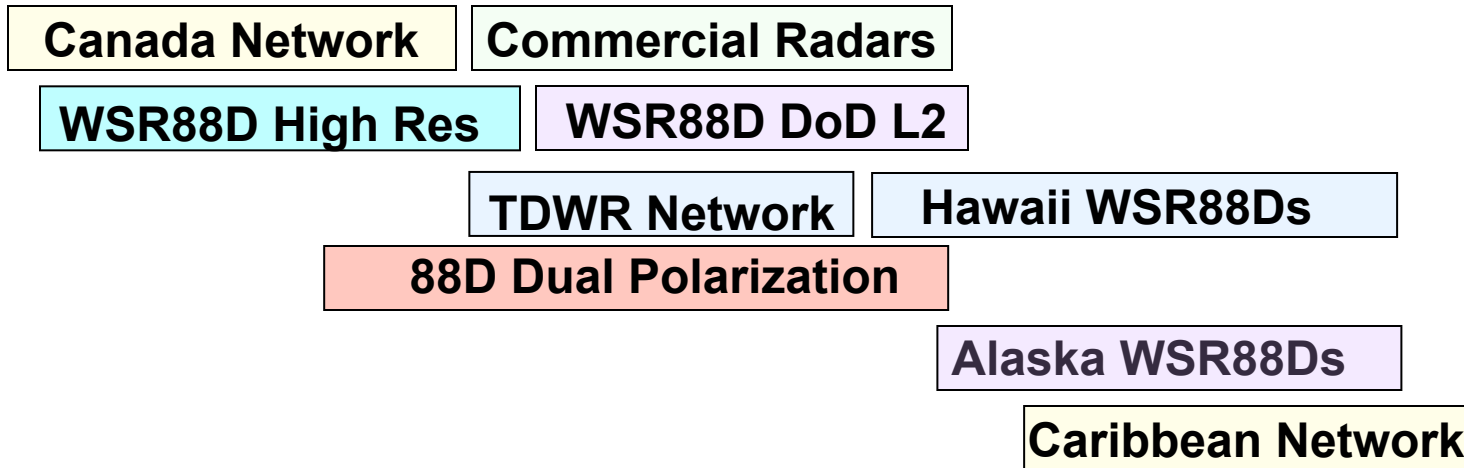




MRMS System Expansion

Seamless Integration of Radar Advances, Systems, and Networks

| | | | | | | | | | | | | | | | |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|--|
| 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|--|



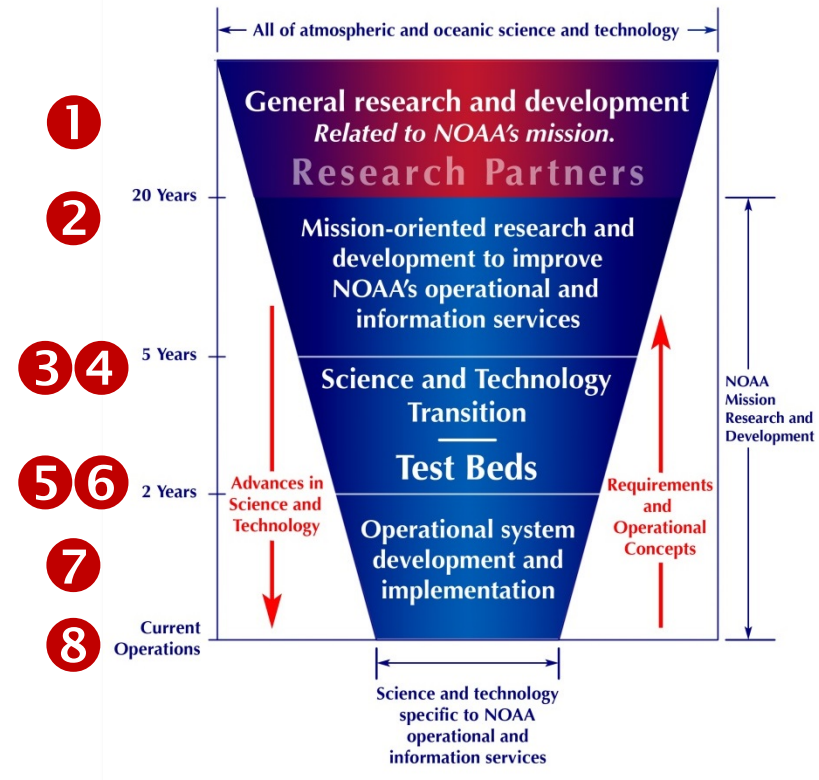
North America Resolution and Refresh Rate



Road to MRMS Implementation

| | | |
|---|-----------------|---|
| 1 | Pre-06 | General R&D on decision support and quantitative precip estimates using radar |
| 2 | Oct 06 | MRMS enters NWS transition process |
| 3 | Nov 10 | MRMS running at FAA Tech Center |
| 4 | Dec 10 | MRMS approved as an official NOAA Line Office Transition Project |
| 5 | May 13 | Funding for MRMS transition |
| 6 | Aug 13 | MRMS Implementation Project charter signed |
| 7 | Aug 13 – Sep 14 | MRMS enters final development and testing at NCEP |
| 8 | Sep 14 | MRMS went operational at NCEP |

NOAA Research and Development Funnel





MRMS R2O Success

- Having The Right People who know The Right Stuff
A NSSL team worked directly with NCEP NCO staff on the operational implementation including **on site training and interactions**
- A R&D Environment that functions Operationally
NSSL built and maintains a real time MRMS system processing environment nearly identical to NCEP in content and data flow to test and evaluate new science and technologies for operational implementation (R2O).

Seamless Transition





MRMS Benefits Hydrology



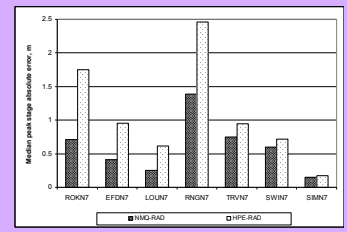
Precipitation Estimation
(WFOs, RFCs, EMC, HPC)

“MRMS/Q2 provides precipitation estimates from portions of southwest Texas, western New Mexico, south central Colorado and Mexico where few if any other sources of precipitation data exist. This area has now experienced major flooding in two of the past four years due to dissipating tropical systems. The loss of Q2 would, in short, mean the loss of what we have seen to be our most accurate radar-based QPE.”
– Greg Story (West Gulf RFC).

- Increases effective precipitation estimation coverage in “radar hostile” regions (terrain, bright-band, hail) by up to 35%
- Provides measured improvements in data QC removing false precipitation echoes, which improves the RTMA, and reduces inaccurate precipitation estimates and unnecessary flash flood warnings.
- Greatly benefits the Western U.S., where there is a combination of major flooding vulnerability and radar coverage gaps.

Integrates lightning sensor data to apply advanced precipitation segregation (convective, stratiform) for more accurate rainfall rates

The **river stage forecast errors** in some basins are **reduced by up to 1 meter** using MRMS/Q2. This improved accuracy will **lead to major savings in flood mitigation efforts** (e.g., sandbagging, evacuations).





MRMS Transition into NCEP Operations

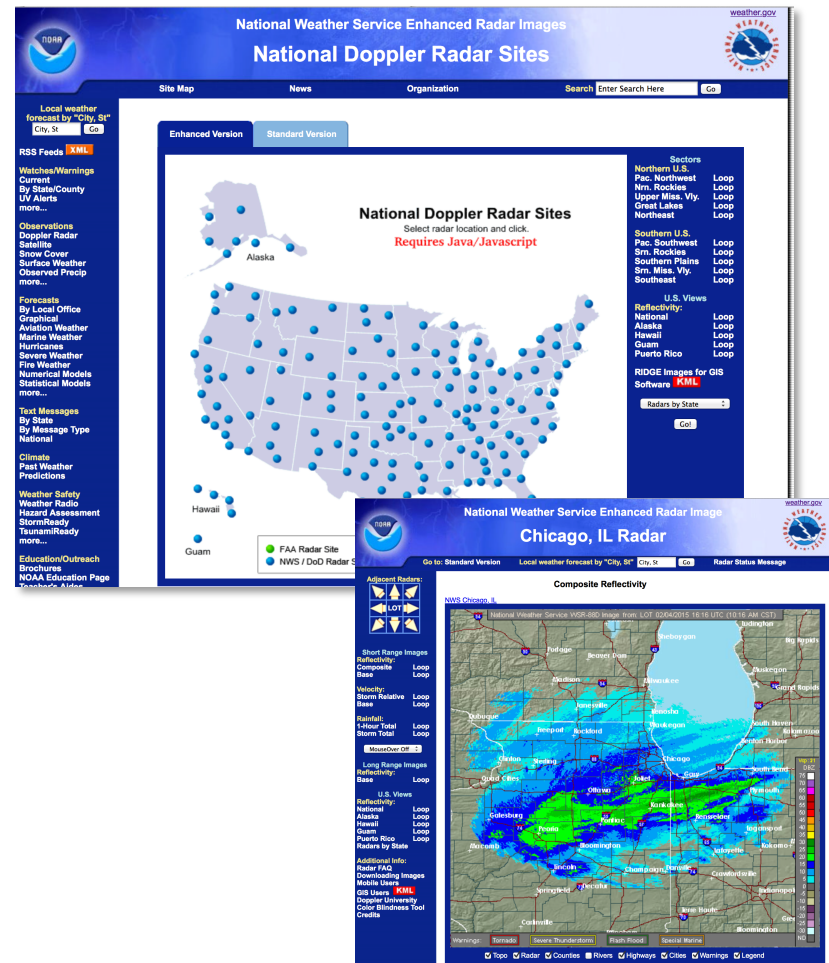
MRMS has been installed on the National Weather Service' (NWS) Integrated Dissemination Program (IDP) Phase II processing farm at NCEP in College Park, MD

- 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 (to be completed in March 2015)



MRMS activities 2015-2016

- MRMS will provide back-end processing for NWS radar mosaic and single radar products for public website (FY15) - **MRMS will become a single authoritative source CONUS wide mosaics**
- Recast portions of MRMS into Gridpoint Statistical Interpolation (GSI) framework at EMC for improved data assimilation
- Expand MRMS domain to Alaska, Hawaii, PR, Guam, and western Pacific
- 3 month update cycle for new products and applications





Summary

~~MRMS Implementation Project provides an example of good practices to transition R&D as well as lessons learned for future transition projects.~~

It took the very best of NSSL to implement a world class system to address some of meteorology's most difficult operational challenges.

And we are not done...

“Most unsuccessful programs fail at the beginning.”

Steven R. Meier, “*Best Project Management and Systems Engineering Practices*,” *Project Management Journal*, Vol 8, Issue 1, March 2008



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