NMQ/Q2 Radar Reanalysis

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Outline

- Motivation
  - Why is this product needed?
  - How does it improve on the current state of affairs?
- Product Introduction
  - Just what is it, exactly?
  - What can we get out of it?
- Pilot Project
  - Sounds nice. What does it look like?
- Next Steps and Long-Term Goals
  - Why isn't it finished yet?

What is this and why do it?

- NOAA does not maintain a high-resolution precipitation product
  - Impacts modeling, forecasting, flood guidance, etc.
- Currently available products have limitations
  - Spatial Resolution
  - Temporal Frequency
  - Accuracy
- NMQ/Q2 represents a significant step in precipitation estimates

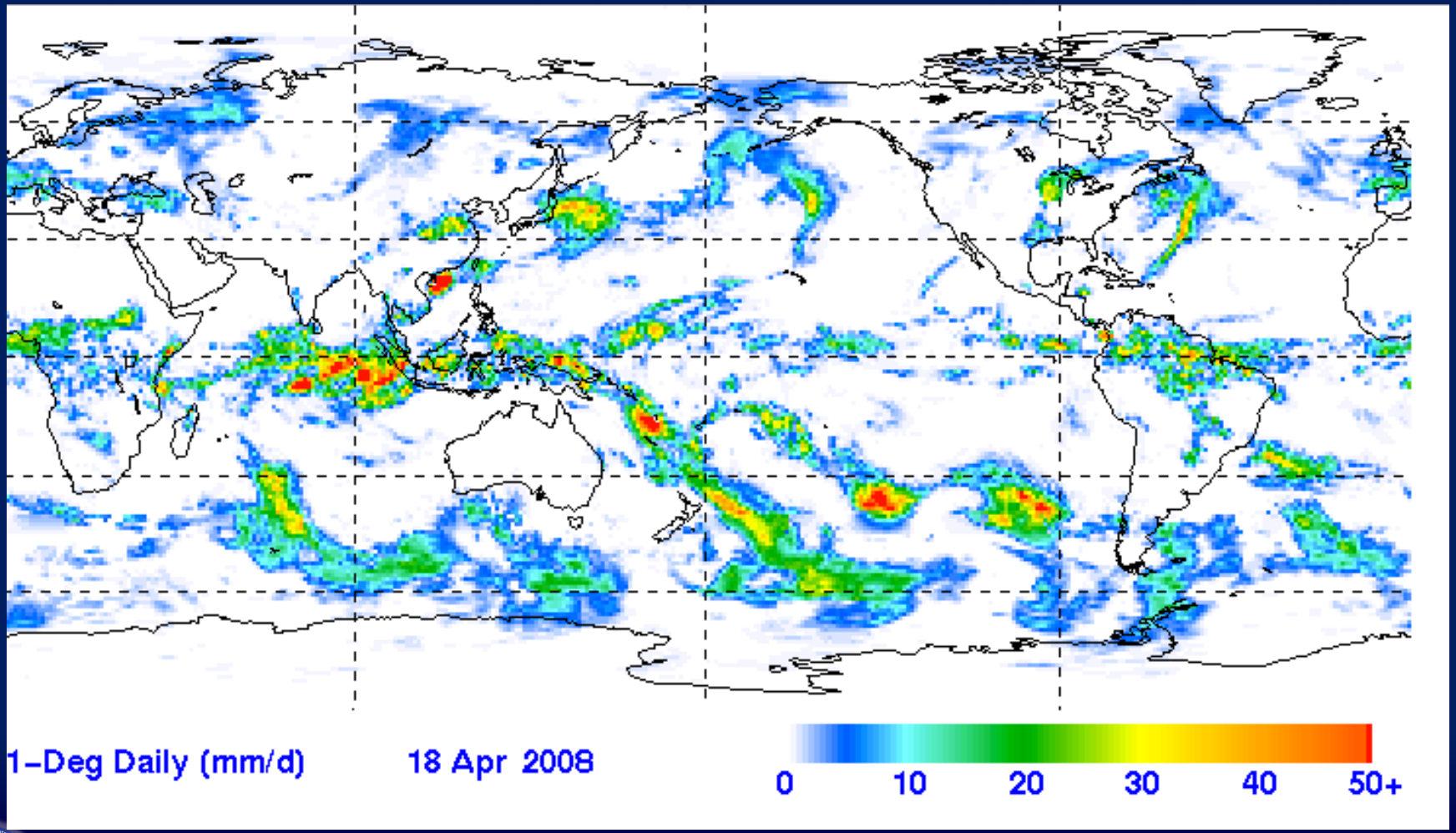
Surely this exists already…

- Global Precipitation Climatology Project (GPCP)
  - 1 day x 100 km (about 3-4 counties)
- TRMM 3B42 (satellite-based)
  - 3 hours x 25 km (small city)
- MPE (radar-based)
  - 1 hour x approx. 4 km (small town)
- Gauge-based precipitation estimates
  - 1 hour – 1 day x approx. 20 km

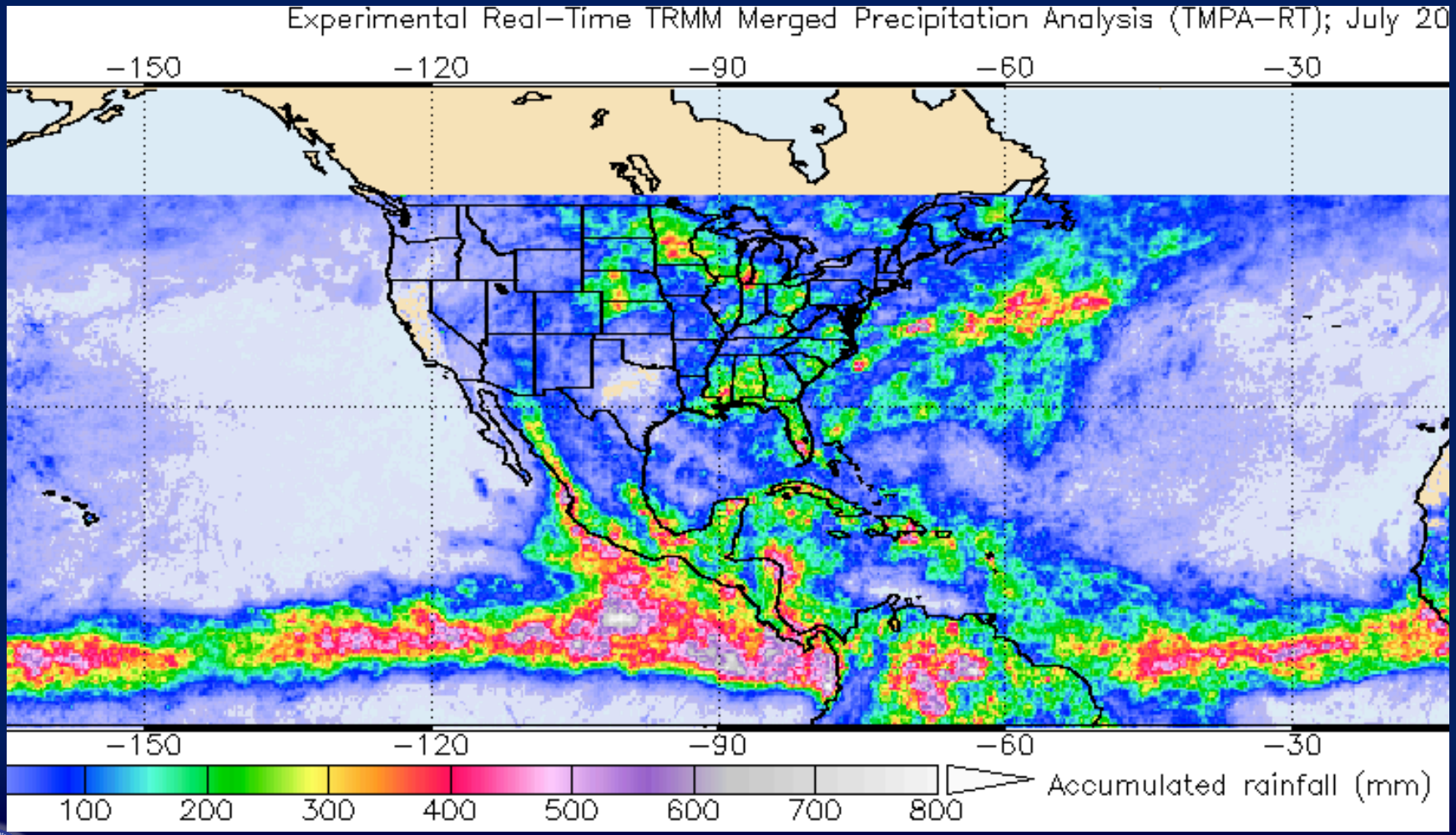
NMQ/Q2: Next Generation QPE

- Developed at the National Severe Storms Laboratory (NSSL) in Norman, OK
  - Research/Development arm of NOAA
- Multi-sensor estimate of precipitation
  - Primarily surface radar-based
  - Incorporates RUC model data and gauge networks
- Represents significant step in resolution
  - 0.01 degree (1-km spatial resolution)
    - Neighborhood scale
  - 5-minute temporal resolution

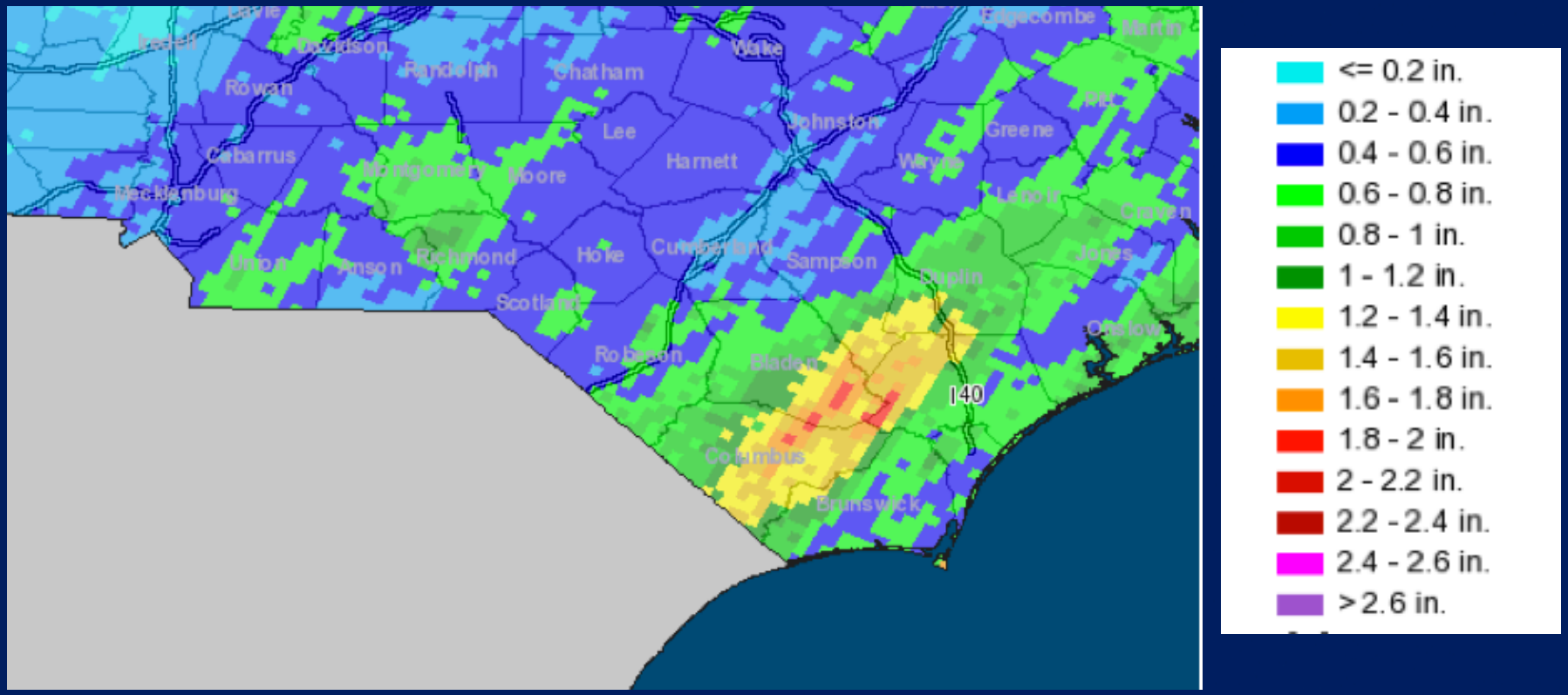
GPCP (100 km) Resolution



TRMM (25 km) Resolution

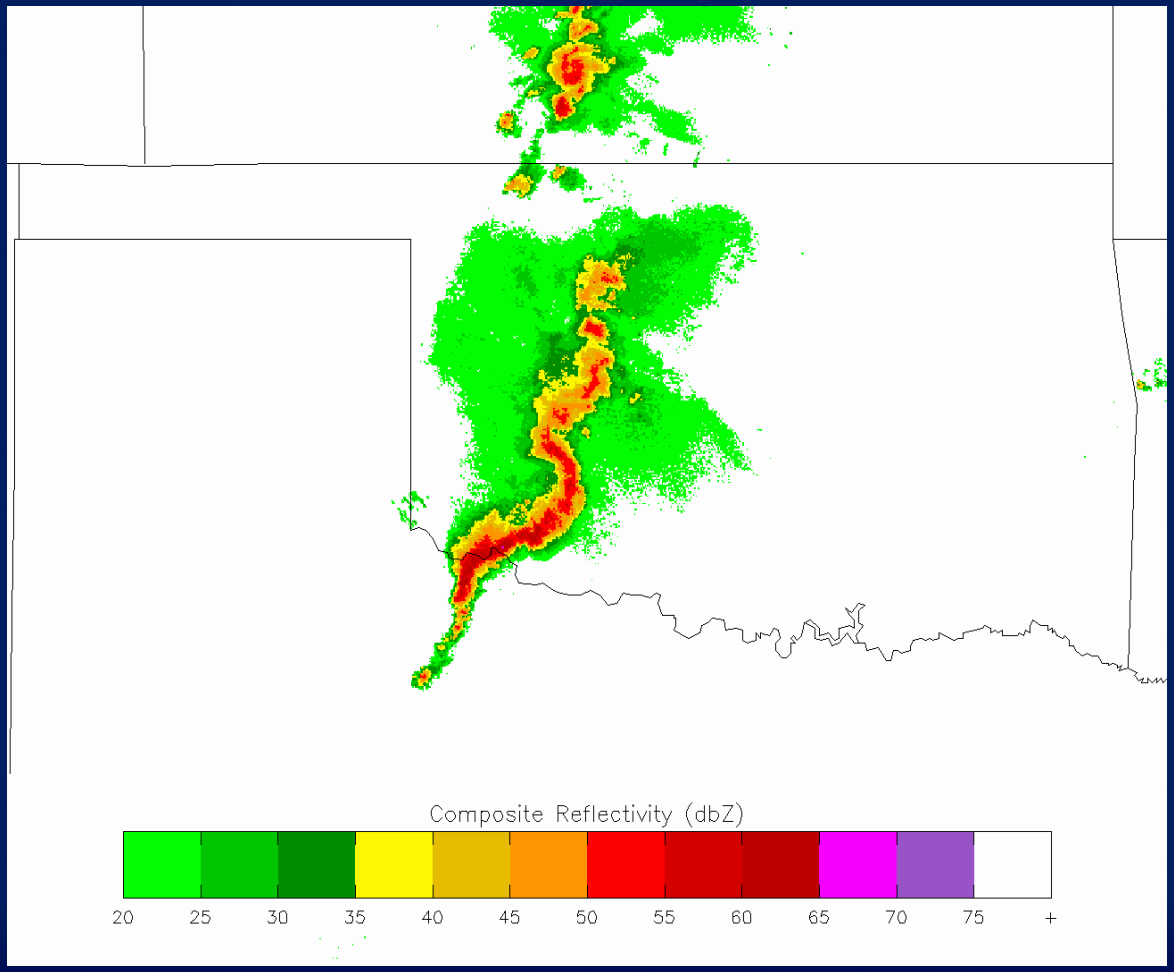


MPE (5 km) Resolution

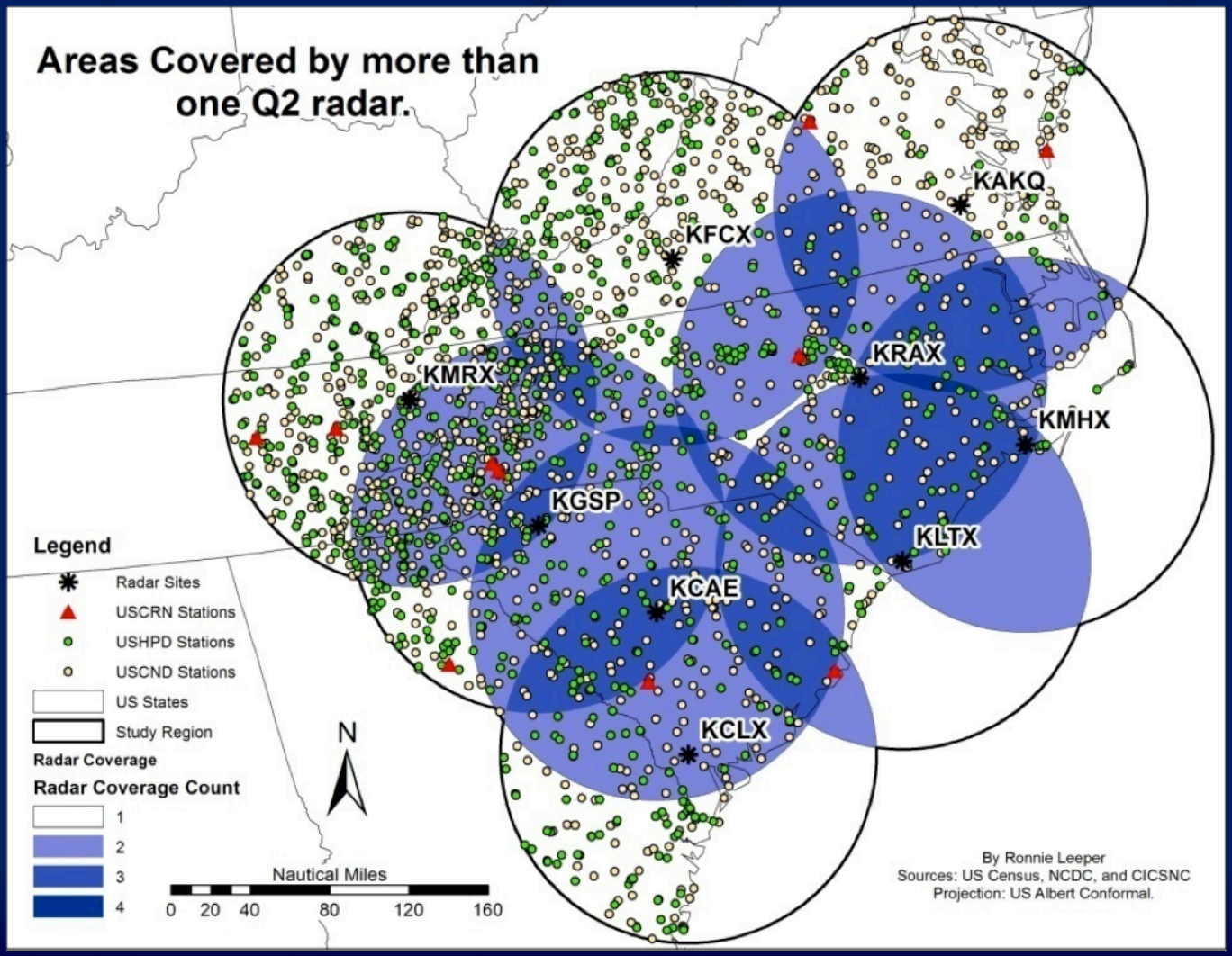


Courtesy: NC State Climate Office

NMQ/Q2 (1 km) Resolution



Q2 Pilot Project (1998-2010)



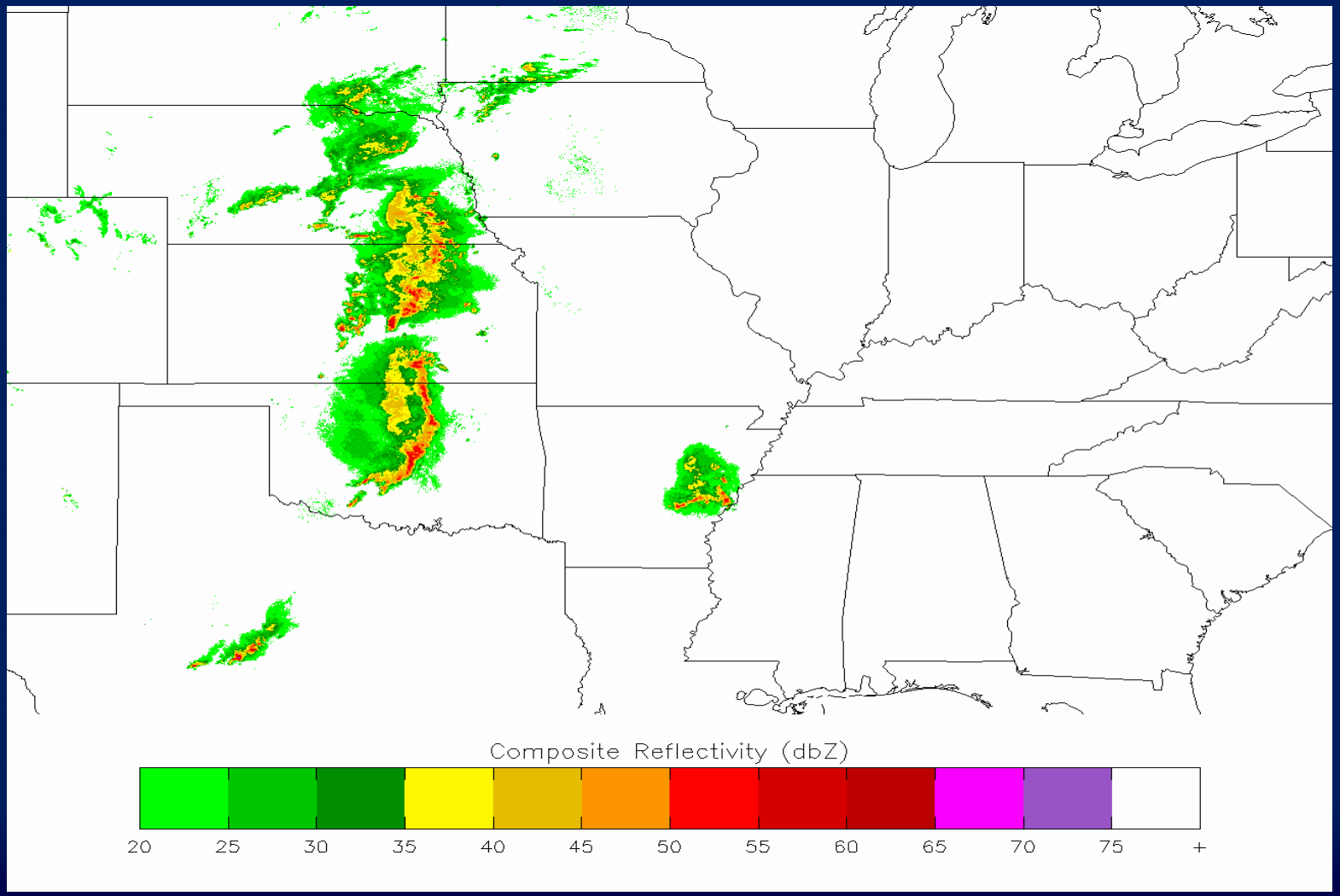
Q2 Process

- WDSS-II (Warning Decision Support System – Integrated Information)
  - Ingests raw radar data and model data
  - Performs QC
  - Merges all radars into a single gridded mosaic
- NMQ (National Mosaic and Multi-Sensor QPE)
  - Performs analysis on gridded data to generate value-added products (bright band, hail statistics, VPR)
- Q2 (Next-generation QPE)
  - Final step of NMQ process, generates precip estimates

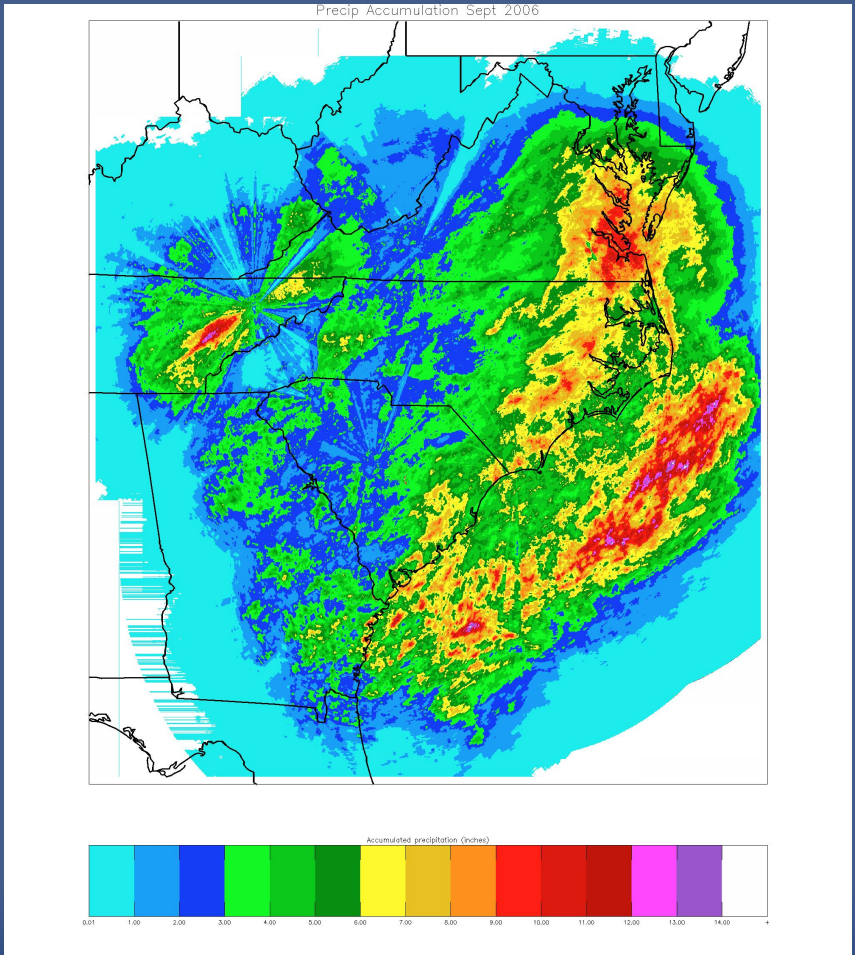
Q2 Output

- Provides precipitation estimates at 1-km resolution every five minutes
- Three-dimensional radar reflectivity
- Various value-added products
  - Echo Tops
  - Bright band heights
  - Vertically integrated liquid, etc.

Mosaic Reflectivity

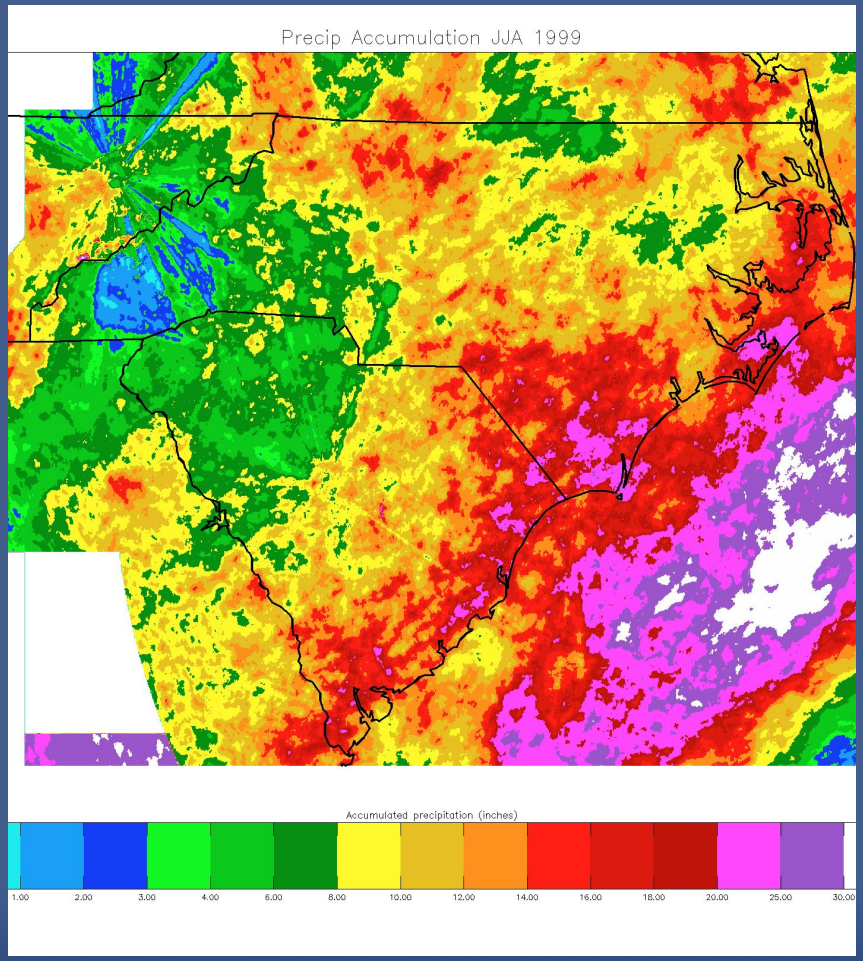


Monthly Accumulation



- Precipitation patterns realistic and comparable to gauge measurements from same time period
- Beam blockage effects evident from radars in mountainous regions (KMRX, KGSP, KFCX)
- Streaking in SW portion of domain result of processing glitch

Seasonal Accumulation



- Beam blockage still evident
- Inconsistency in SW portion of region still result of processing

Current Status

- Working toward expanding to cover the entire continental US
- Receiving frequent software updates from NSSL
- Adapting for use on a parallel computing system
  - Stringing steps together into single scripts
  - Data organization
- But there are challenges…

Issues that have arisen

- Computing horsepower
  - Each radar must be processed one day at a time
  - 140 radars x 365 days x 15 years = 766,500 individual scripts to be run just for the first half
  - Memory limitations
    - Mosaic process requires a large amount of RAM
    - Having difficulty finding enough machines that can run it
- Size of data
  - Difficult to find a place to stage and store all of the input and output data involved

Just how much data?

- GHCN-M: Global monthly temperature record for all of recorded history – 100 MB
  - Used for "warmest month" statements, often referred to in climate publications
- Standard DVD: 4.7 GB (about 48 times as much)
- Level-II NEXRAD archive: 150 TB
  - 1.5 million times the size of the temperature record
  - 32,000 DVDs
  - Growing by over 50 GB every day
    - Takes less than 3 minutes to accumulate 100 MB

Applications

- If product is made operational
  - High-resolution precipitation estimates at near real-time
    - Flash flood guidance at 1-km resolution
    - Short-term hydrology forecasting
- Research Applications
  - Endless possibilities for climatological studies
    - Orographic influence
    - Tropical cyclone precipitation contribution
    - Contributions from individual storm events
    - Very precise querying
      - How much did it rain on my house from 11:05 – 11:25 on February 17, 1999?

The Goal

- Archived Precipitation Estimates
  - Full reanalysis of all US NEXRAD data for period of record
  - Put in NCDC archive as climate data record for future research in other applications
- Using reanalysis mode to provide feedback to NSSL
  - Can be quickly reprocessed under different circumstances
  - Identify strengths and limitations to improve product

Summary

- Very exciting but intensive project
  - Improve resolution of precipitation estimates by a factor of nearly 5
  - Improve time resolution from hours to minutes
- Create a homogeneous, easily searchable database of precipitation records from the mid-1990s to present
- Always improving algorithms to increase accuracy
  - Reanalysis mode will allow us to re-process the data more quickly

Questions?

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