



# Quantitative Precipitation Estimation in the National Weather Service

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# Quantitative Precipitation Estimation in the National Weather Service

A **Multisensor** Approach to Optimally Combine  
Information from Multiple Sensors



Radar



Rain Gauges



Satellite

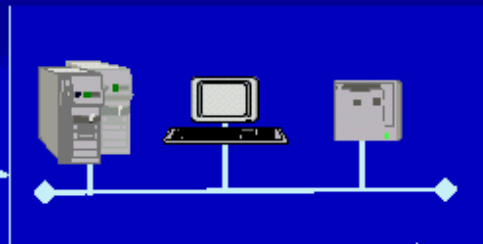
# Quantitative Precipitation Estimation in the National Weather Service

A Blend of **Automated & Interactive** Procedures

**RDA: Radar Data Acquisition**  
(Transmit energy, receive data)



**RPG: Radar Product Generator**  
(Scientific Processing)



**AWIPS: NWS Forecast Office**  
(Forecaster Warnings)

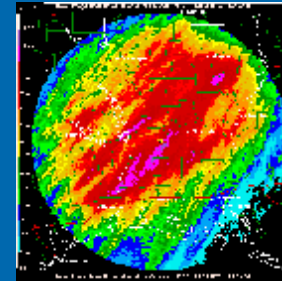


# Quantitative Precipitation Estimation in the National Weather Service

Multistep, Integrated, End-to-end Processing  
from Local to Regional to National Levels

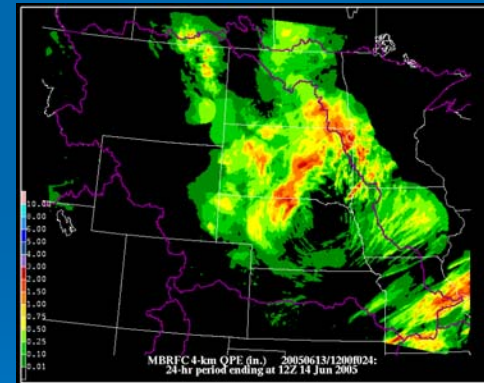
## ➤ Local

- Single WSR-88D radar-only
- Precipitation Processing System (PPS) on the Radar Product Generator



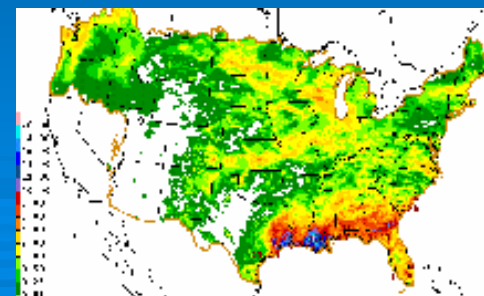
## ➤ Regional

- Radar-gauge-satellite rain mosaics for multistate RFC forecast regions
- Multisensor Precipitation Estimator (MPE) on AWIPS

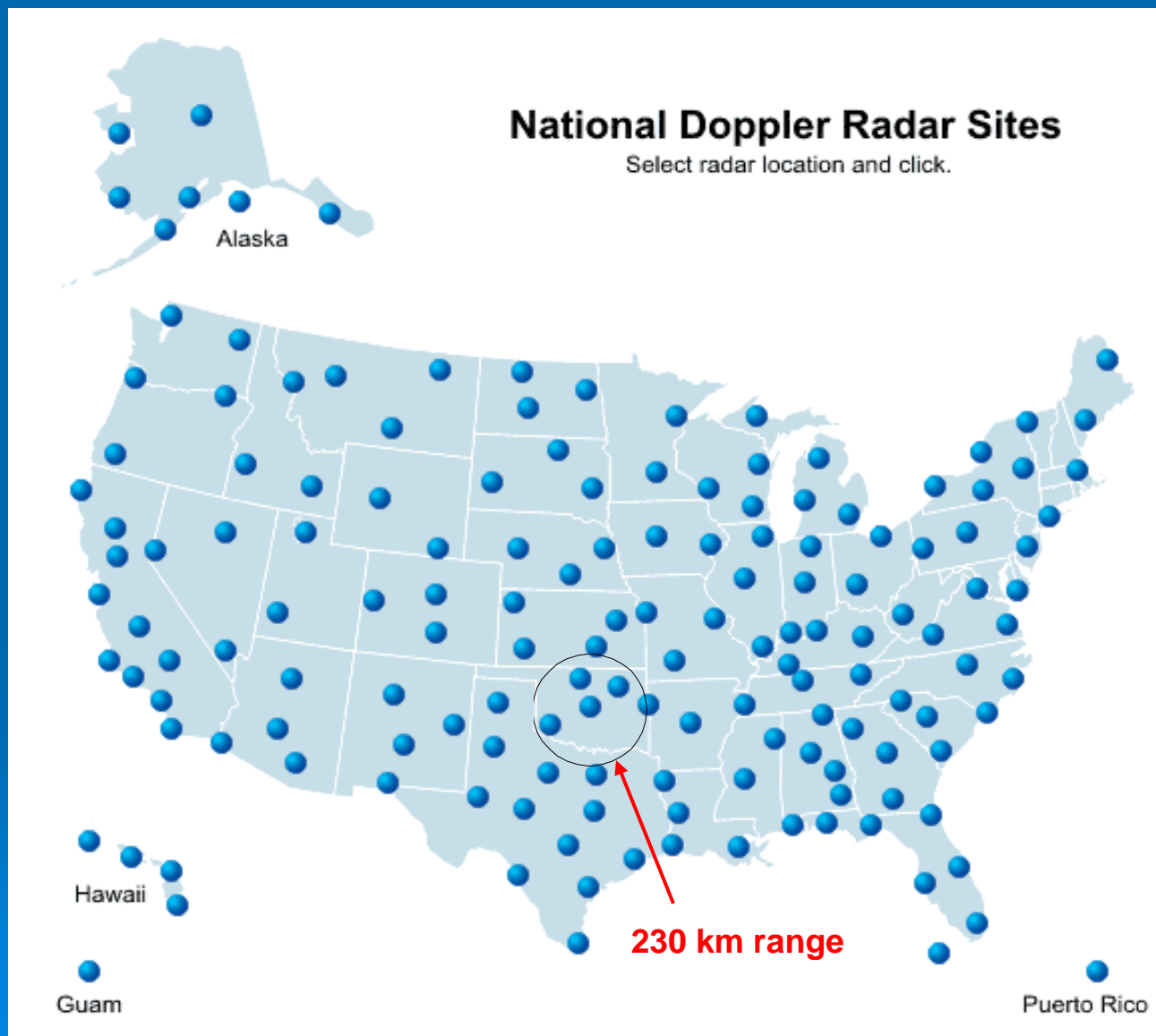


## ➤ National

- Nationwide mosaics of 6-hr & 24-hr MPE rain
- Stage IV Precipitation Processing at NCEP



# 160 WSR-88D Doppler Radars



# First Step (Local)

Generate single-radar rainfall products at each WSR-88D every 5 minutes using **Precipitation Processing System (PPS)**

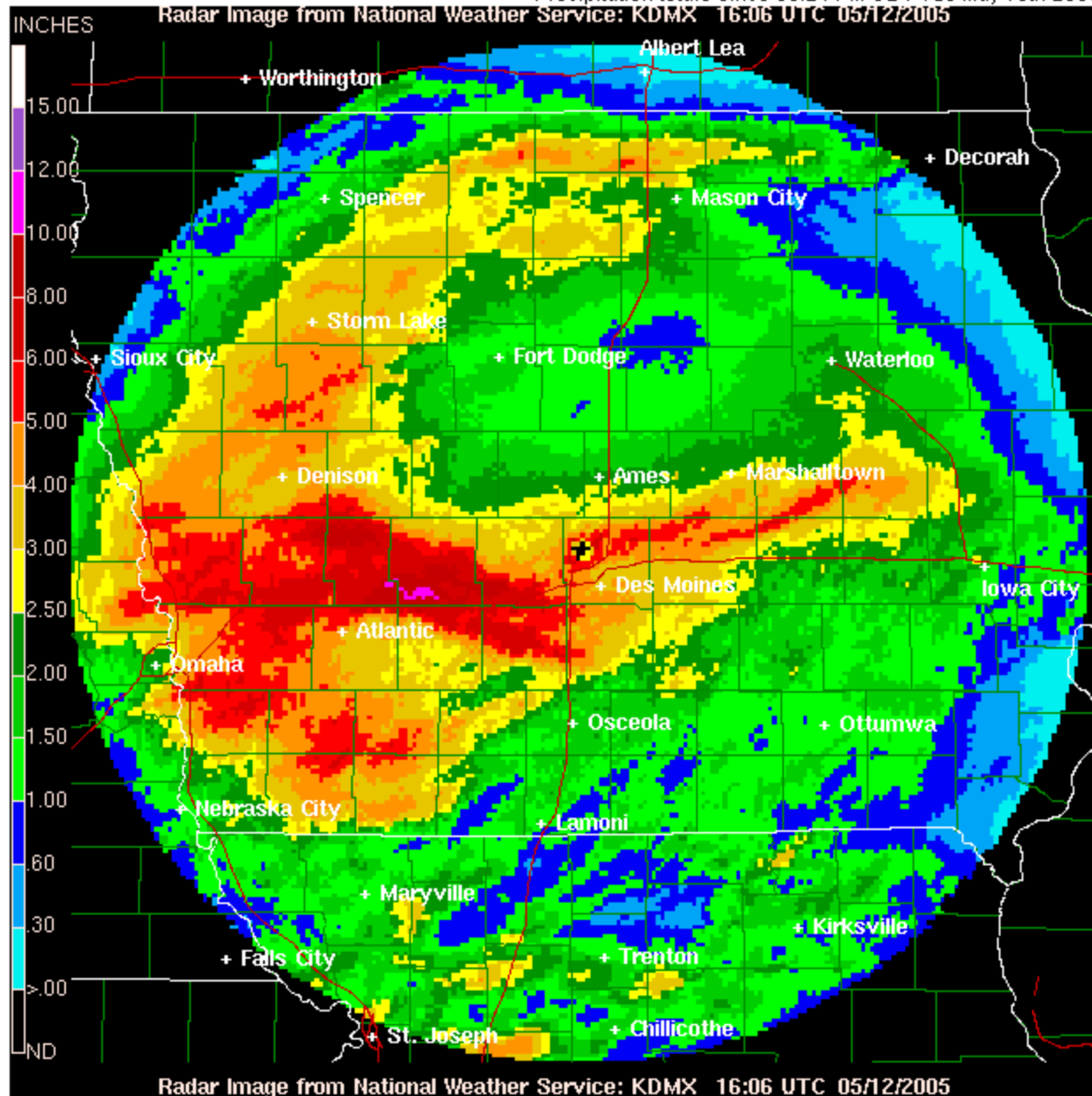
- Quality control near-ground radar reflectivity data
- Account for beam blockages by terrain
- Compute and apply range corrections for vertical reflectivity gradients (future)
- Convert reflectivity to rainrate to accumulation
- Apply mean-field raingauge-radar bias correction to account for site-specific calibration and/or Z-R errors
- Generate digital and graphical rainfall products for customers and follow-on processing steps

# Storm Total Rainfall

[Des Moines, IA Homepage](#)

11:09 AM CDT Thu May 12th 2005

Precipitation totals since 06:24 PM CDT Tue May 10th 2005

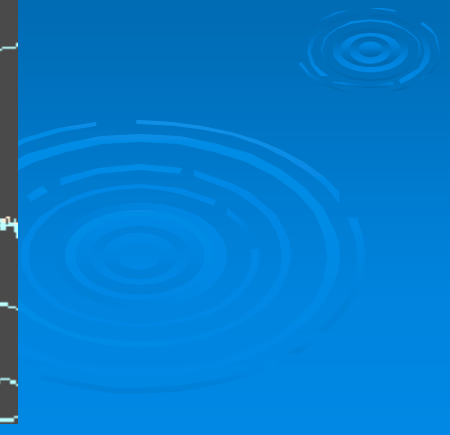
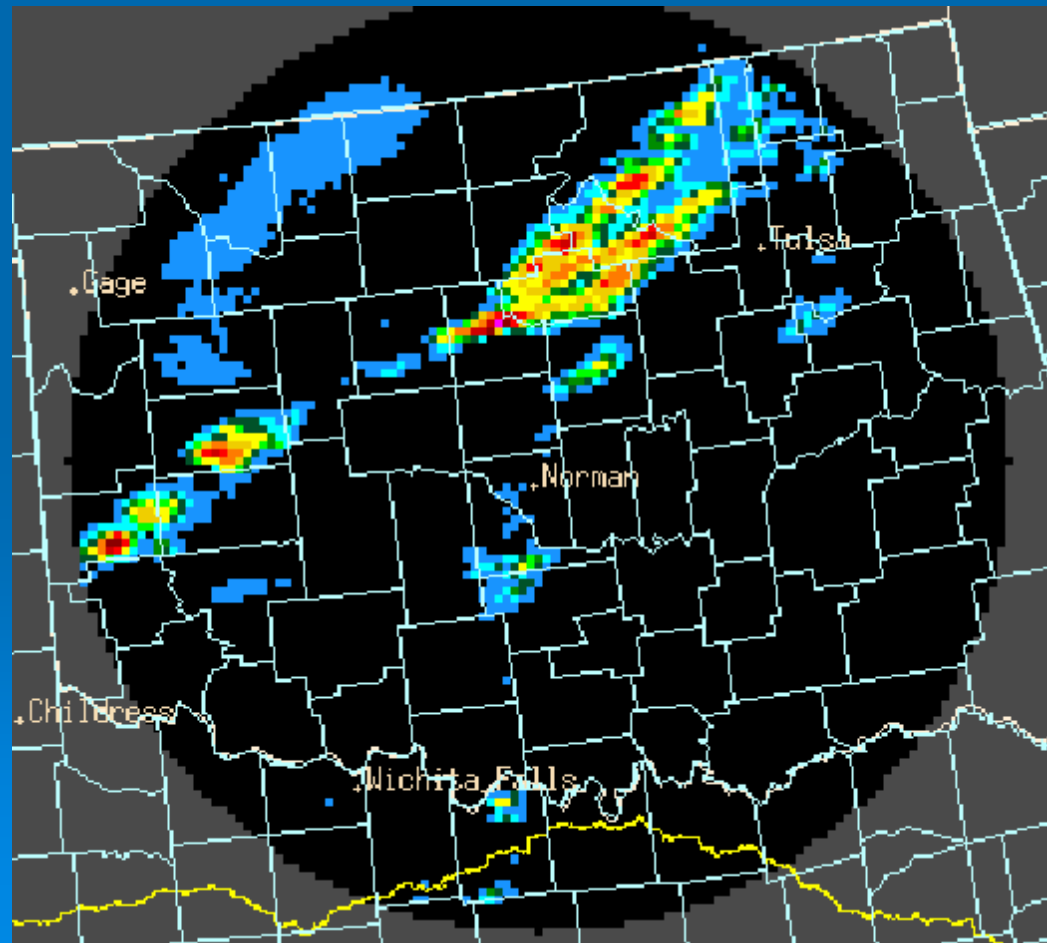


Graphical 16-level  
image products out  
to 230 km range

1-hr, 3-hr, storm-  
total, & user-  
defined  
accumulation  
periods

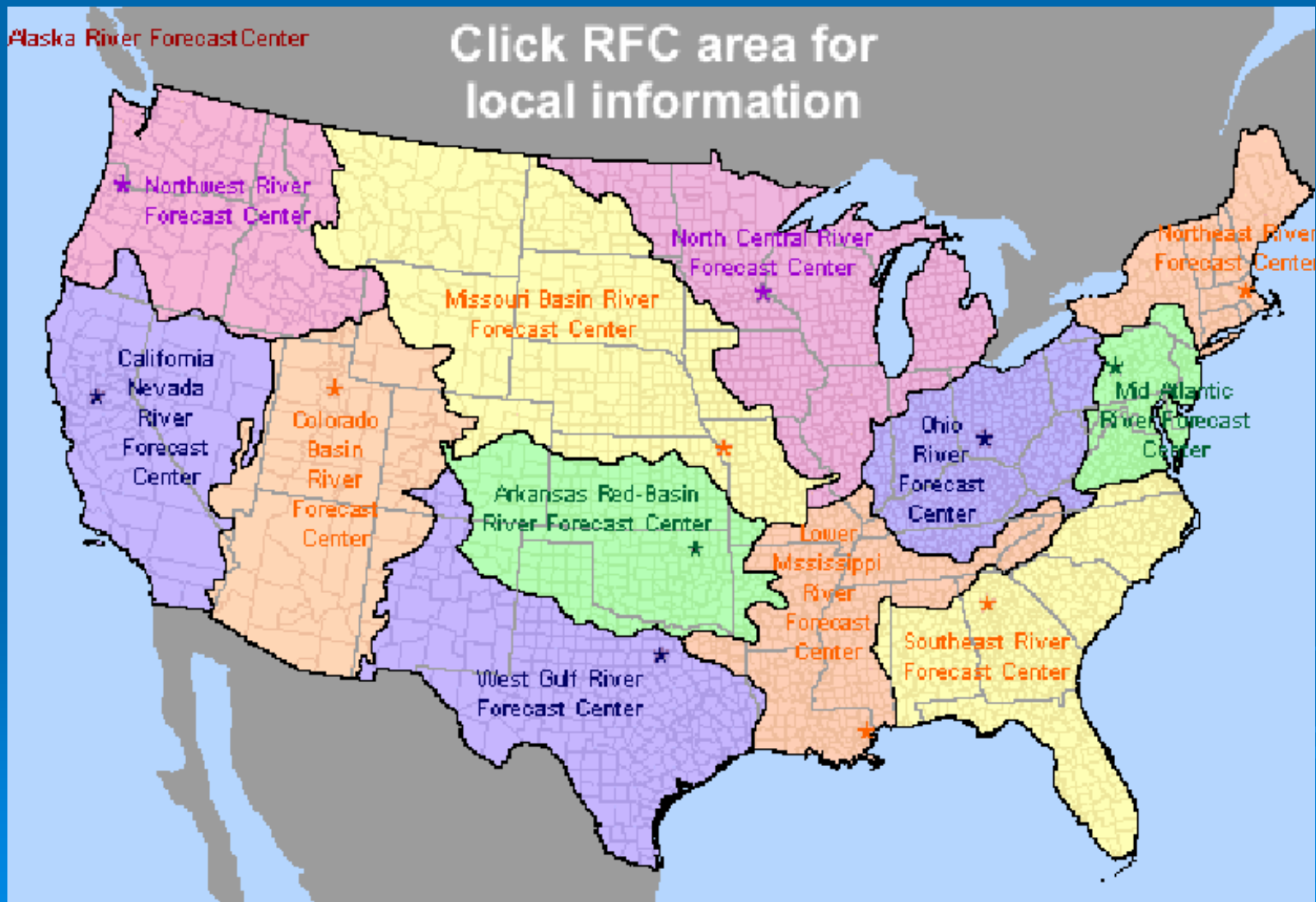
# Hourly Digital Precipitation Array (DPA)

- Rectilinear ~4-km national polar stereographic grid
- 256 rainfall data levels
- Used in follow-on quantitative rainfall applications (MPE)

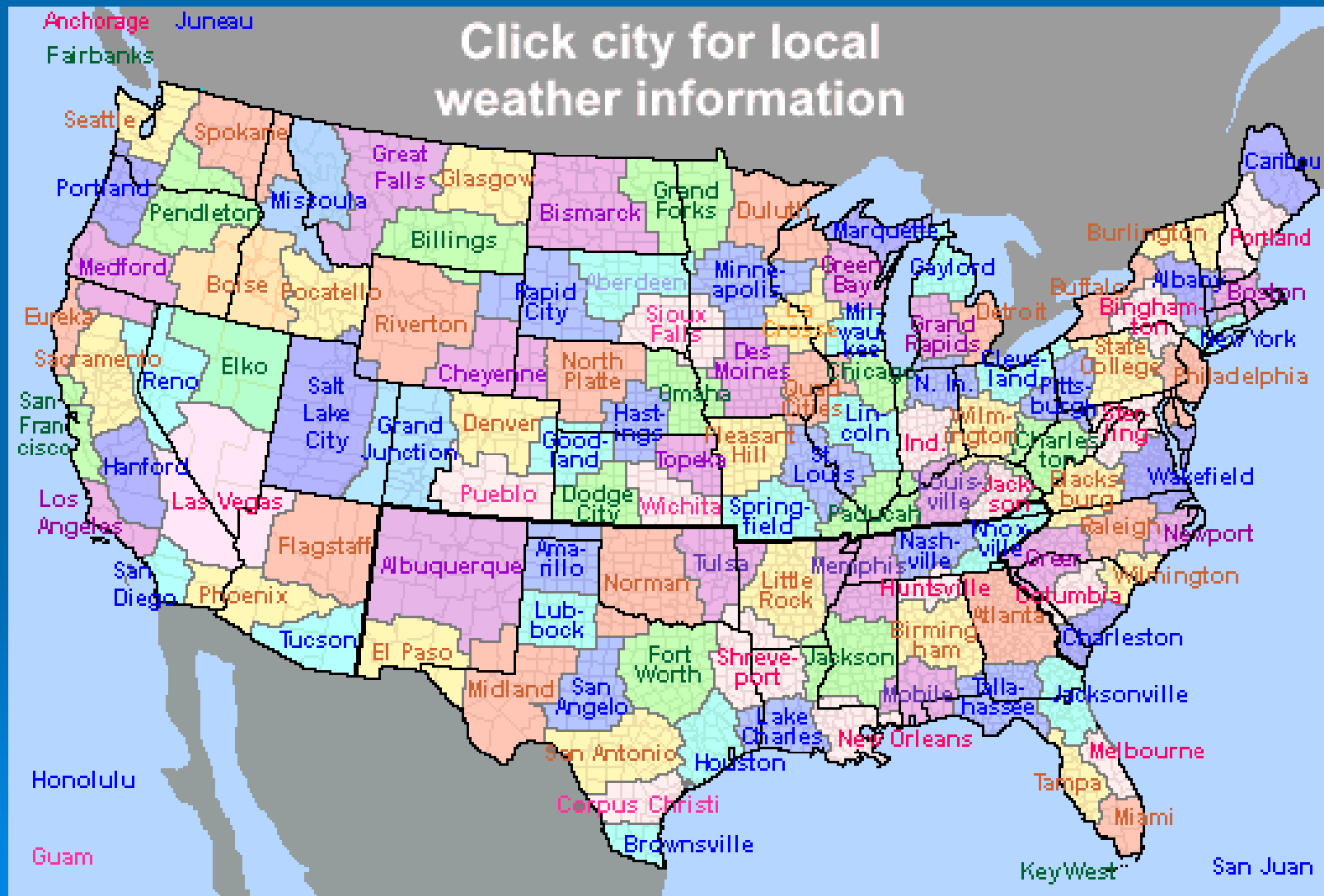




# 13 River Forecast Centers



# 122 Weather Forecast Offices

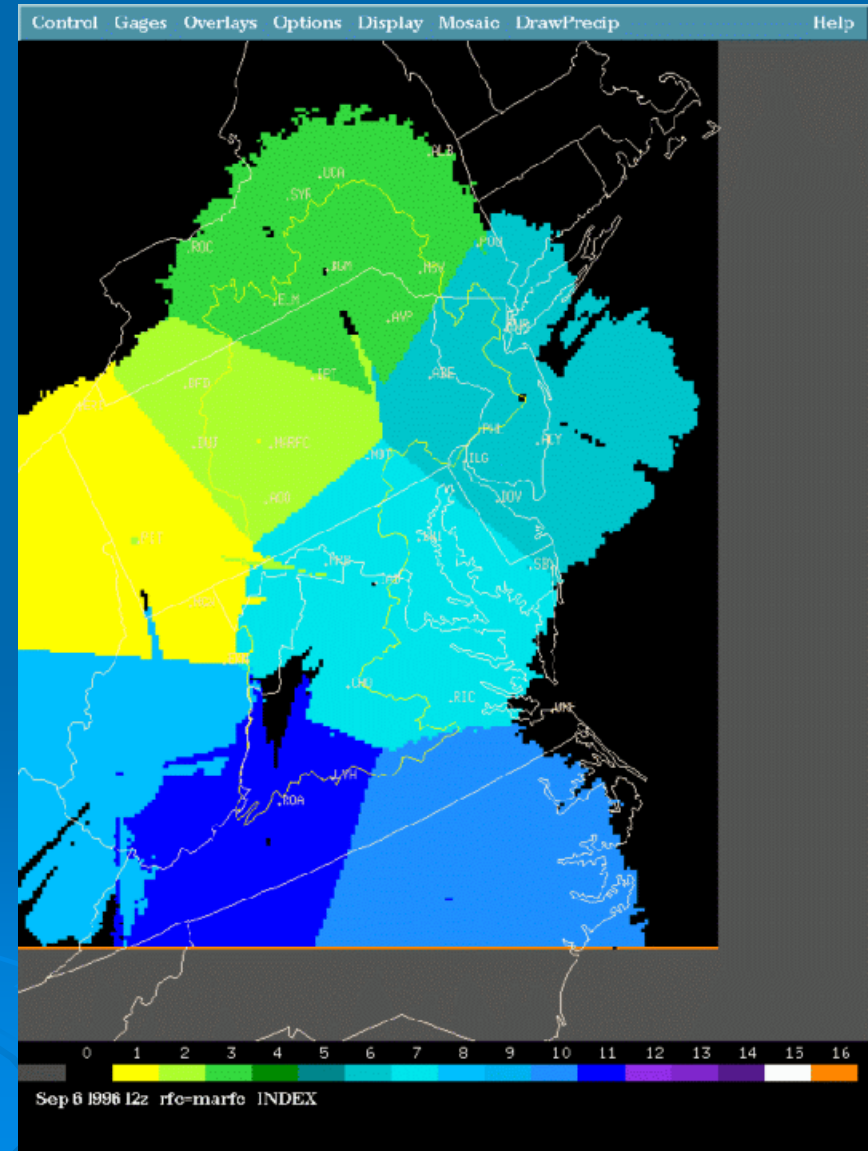
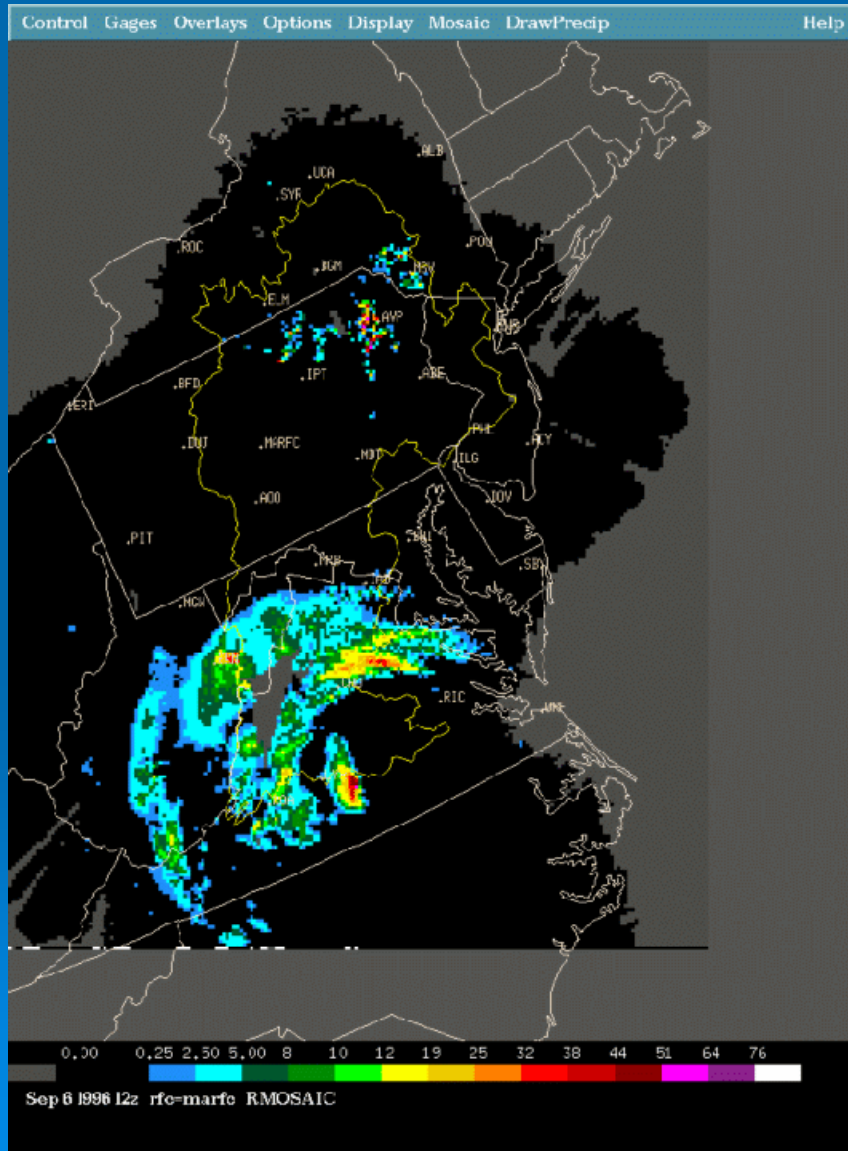


# Second Step (Regional)

Generate ~4-km regionally-mosaicked hourly multisensor rainfall products at each RFC and WFO using **Multisensor Precipitation Estimator (MPE)**

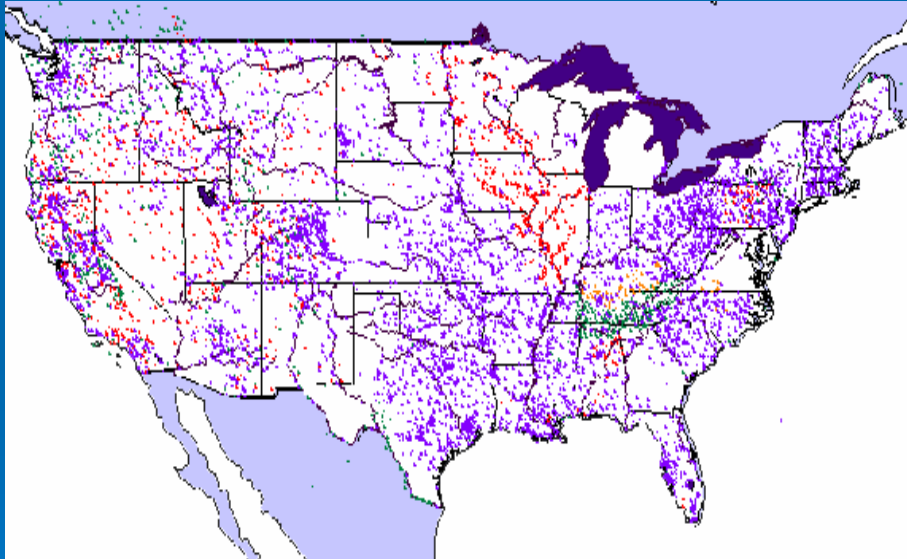
- Compute & apply hourly mean-field raingauge-radar corrections for each WSR-88D radar in forecast area
- Regionally mosaic these hourly rainfall products
- Merge **radar, gauge, and satellite** rainfall estimates on a pixel-by-pixel basis to generate optimal multisensor rainfall grids
- Interactive quality control of real-time rain gauge, radar & satellite rainfall estimates; iterate the above if needed
- Generate optimal hourly regional multisensor rainfall mosaic products on the 4-km HRAP grid

# Example of a mosaicked hourly radar rainfall product from MPE

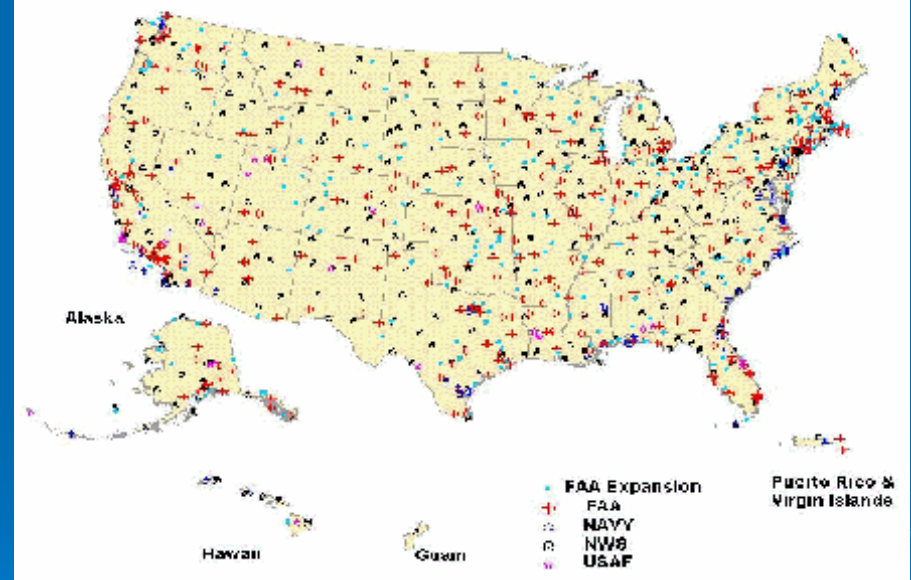


# Utilize available real-time automated hourly rain gauge data

## GOES Data Collection Platform Locations

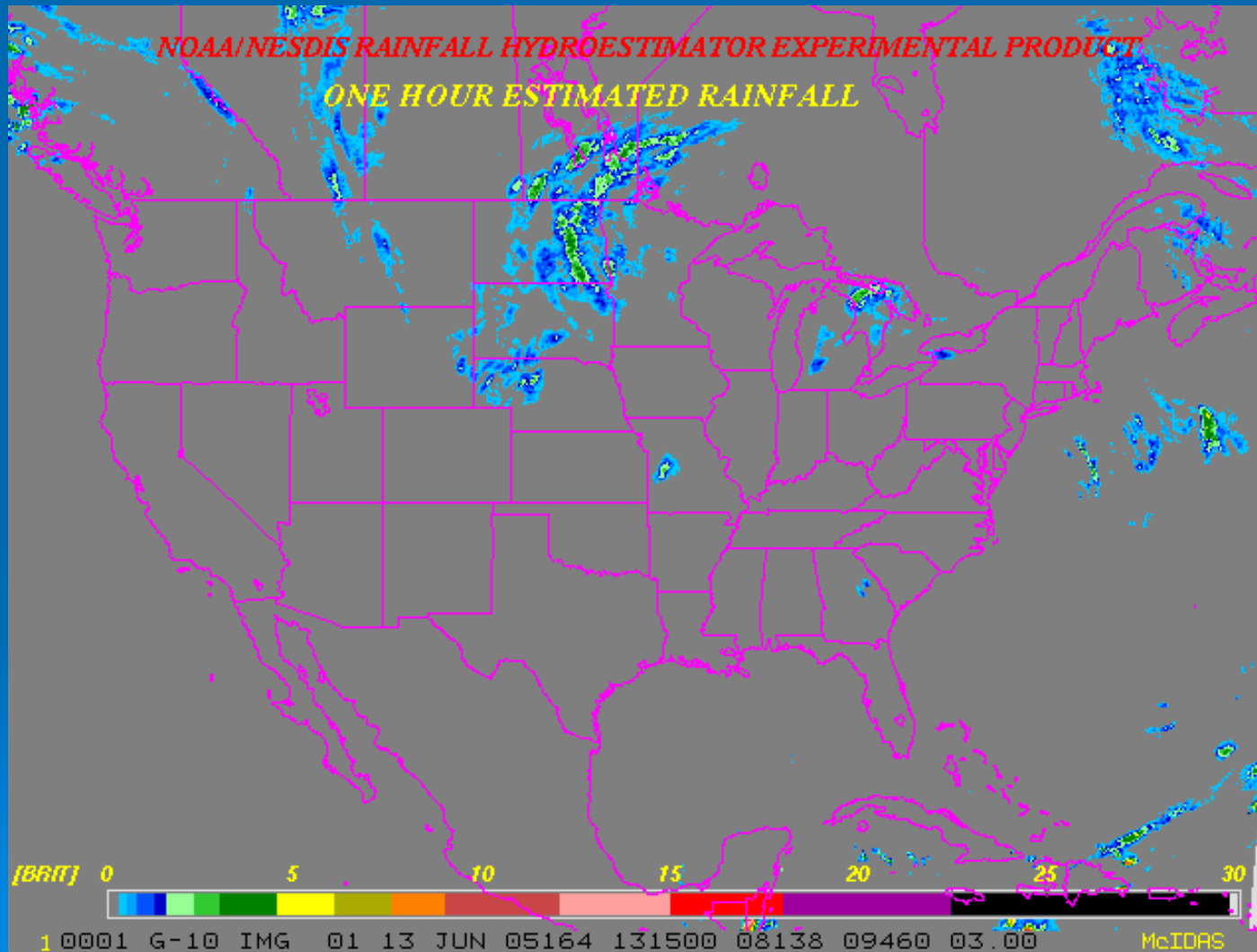


## ASOS Locations



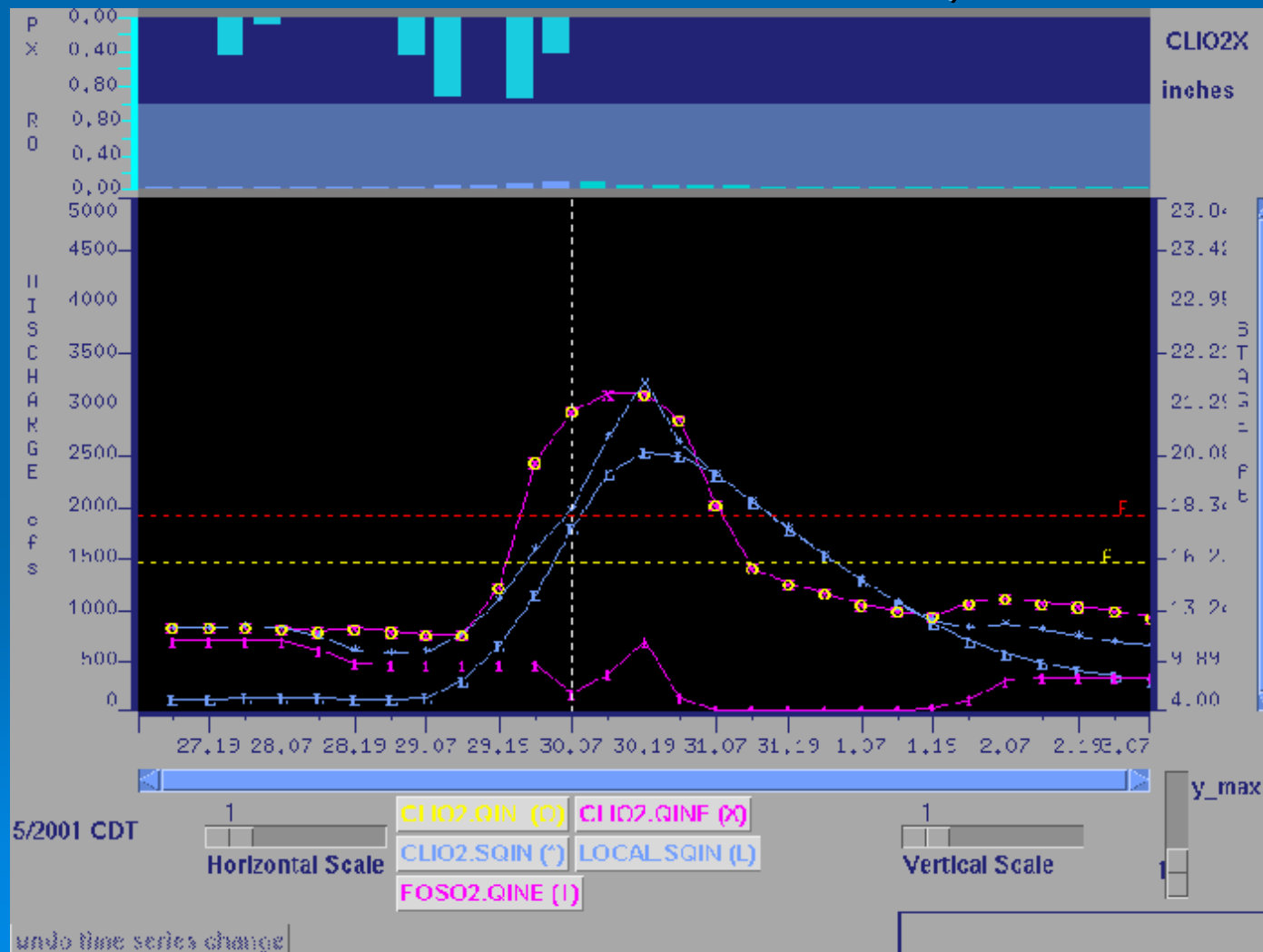
Other networks:  
ALERT, IFLOWS, local  
networks

# Utilize GOES Infrared Satellite-based 1-Hr Rainfall Estimates from NESDIS

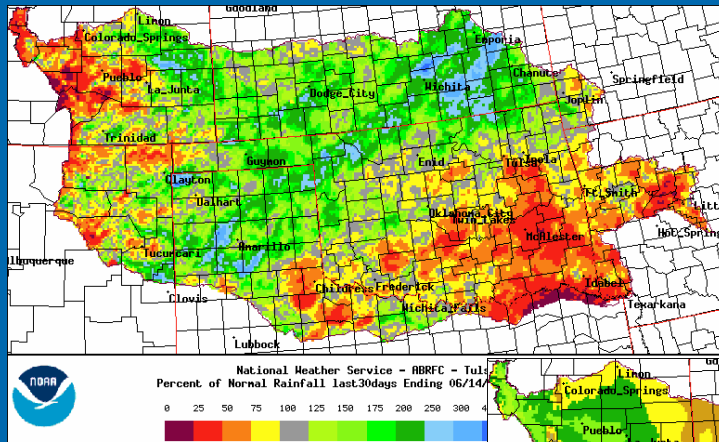


Remapped  
onto 4 km  
HRAP grid  
for use in  
MPE

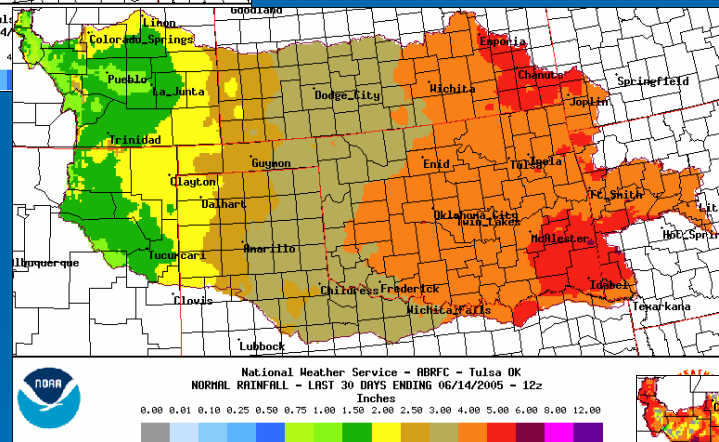
Regional hourly multisensor rainfall products  
may then be used as input to  
NWS hydrologic forecast models (lumped now;  
distributed models soon)



# Regional hourly multisensor rainfall products can be used to monitor long-term rainfall and soil moisture

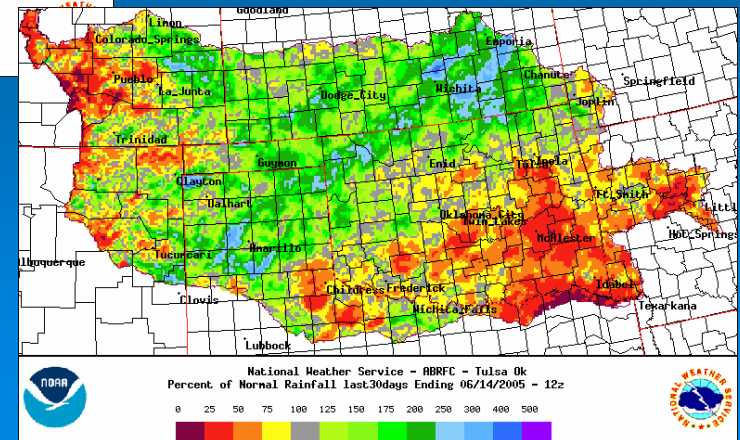


Observed Rainfall last 30 days



Normal Rainfall last 30 days

## Percent of Normal



Example from Arkansas-Red Basin River Forecast Center



# Third Step (National)

## Generate National Gridded Rainfall Mosaics

- NWS/NCEP performs national ~4-km “Stage IV” mosaicking for 6-hr and 24-hour durations using RFC’s MPE regional hourly mosaics
  - <http://www.emc.ncep.noaa.gov/mmb/ylin/pcpanl/stage4/>
- Used as input to NWS numerical weather prediction models to improve quality of:
  - 4-d data assimilation of precipitation (Eta Data Assimilation System) and short-term Eta model precipitation forecasts
  - Other water cycle model components, e.g., soil moisture
- Used for verification of QPFs from NCEP NWP models and HPC and RFC forecasters
- National 24-hr (12z-12z) & monthly rainfall mosaics from summing RFC’s MPE products also available at [http://www.srh.noaa.gov/rfcshare/precip\\_analysis\\_new.php](http://www.srh.noaa.gov/rfcshare/precip_analysis_new.php)

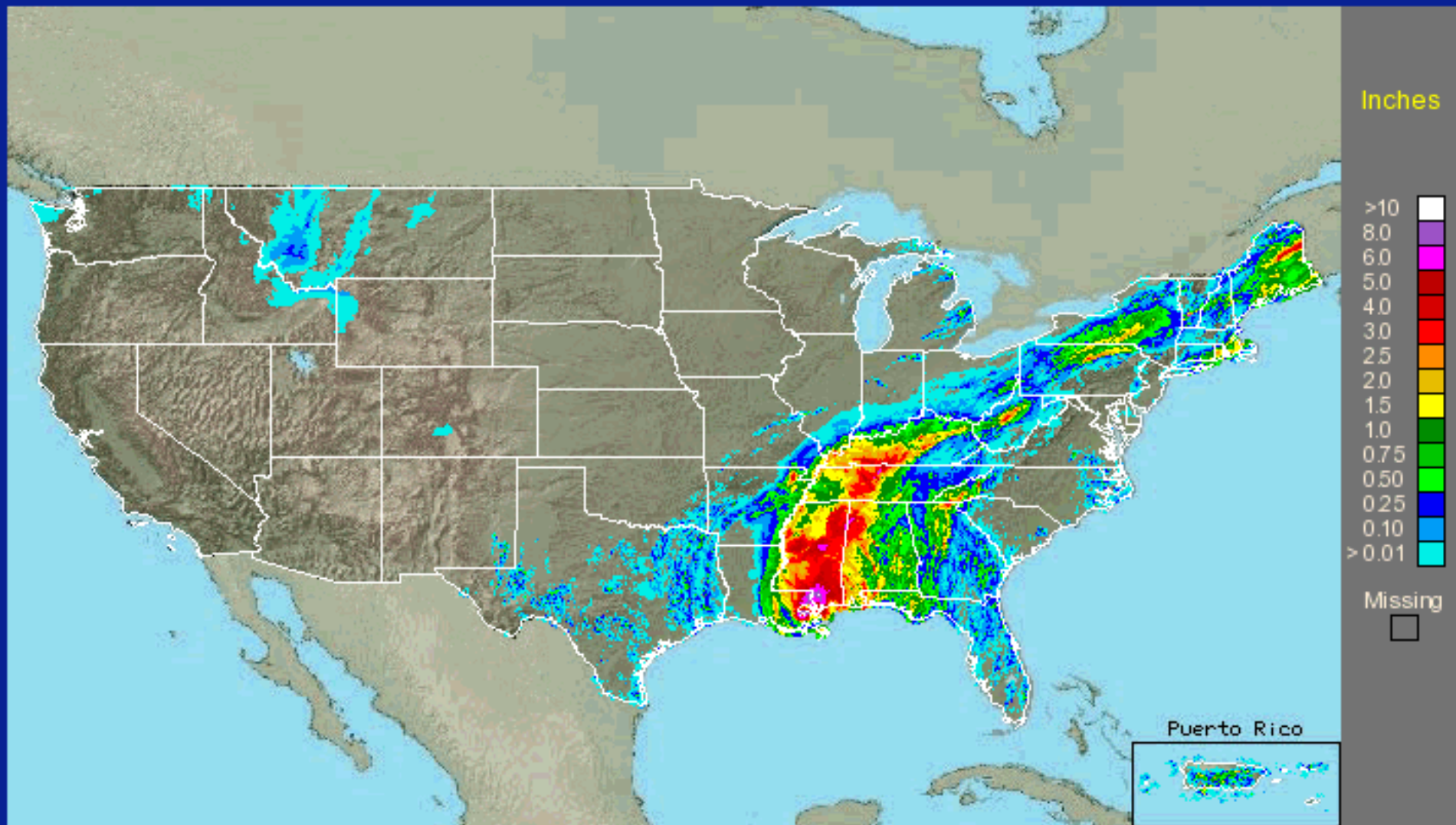
Reference: Lin Y. and K. Mitchell, 2005: The NCEP Stage II/IV Hourly Precip. Analyses: Development and Applications, 19<sup>th</sup> AMS Hydrology Conf., San Diego, CA.

# Hurricane Katrina

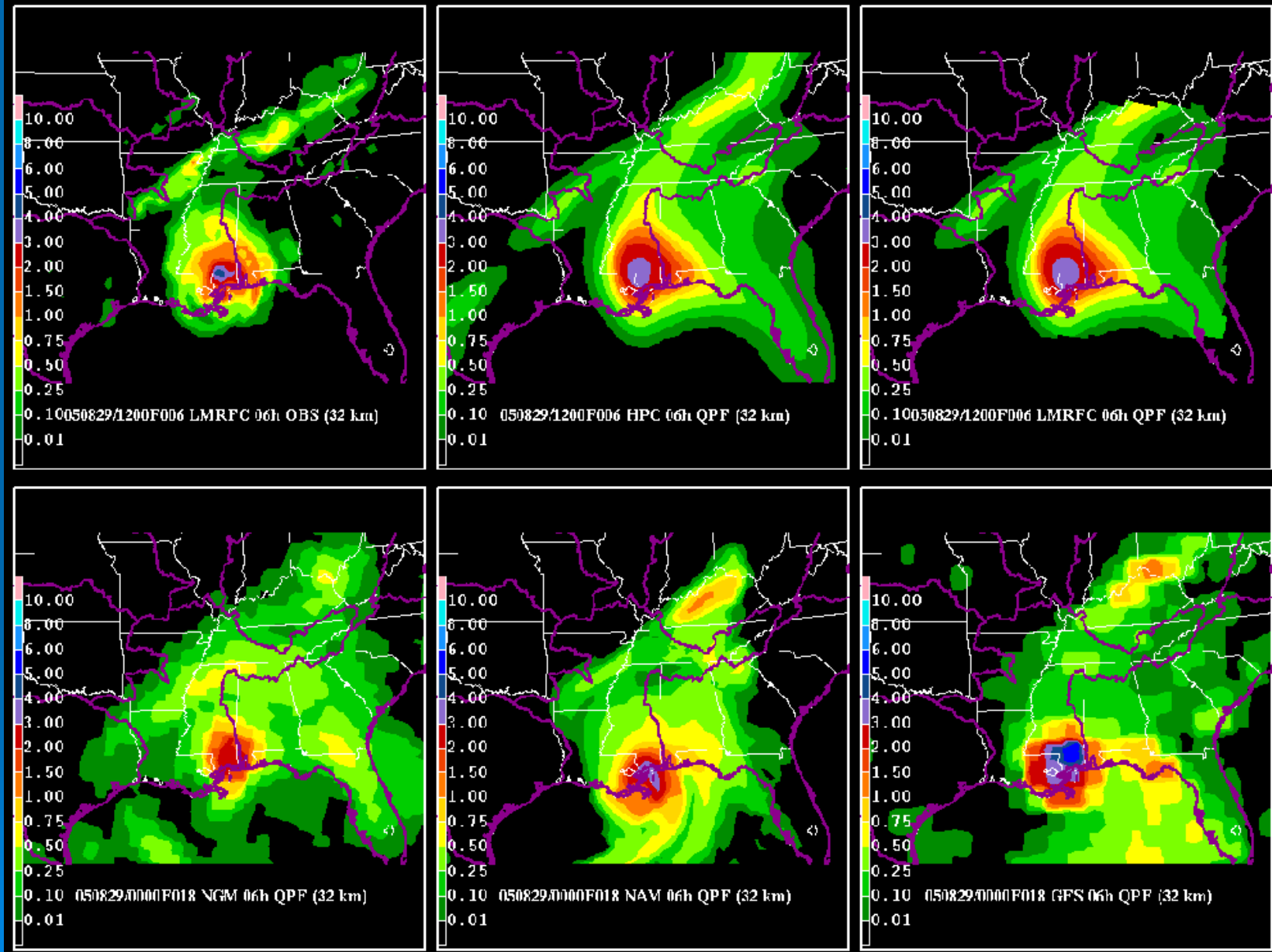
## 24-hr MPE Rainfall Mosaic

Continental United States  
1-Day Observed Precipitation - Valid 8/30/2005 1200 UTC

*Click on the image to zoom in*  
*Click on "States" to zoom out*



# Comparing MPE Observed vs. Forecast Rain



<http://www.hpc.ncep.noaa.gov/npvu/qpfv/>  
<http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/scores/>



# Summary



## NWS Operational Quantitative Precipitation Estimation products are:

- Multisensor...for optimal rainfall estimation
- Multistep processing...for distributed computing and data flow efficiency
- Blend of automated and human-interactive techniques...for flexibility and improved quality
- Peer reviewed and based on 15 years of operational experience in the U.S.
- Applicable to a wide range of geographic locations and climate regimes
- Used for a wide range of applications
- Not perfect...improved techniques are being developed