NOAA's Water Resource Information

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Outline

- Precipitation sources in NOAA
  - Rain gauge measurements
  - Radar rainfall estimates
  - Satellite precipitation estimates
- Issues with the above sources
- Multi-sensor approach
  - Multi-sensor Precipitation Estimator (MPE)
    - MPE-Integration of Satellite Precipitation Estimates
  - Next-generation Multi-sensor QPE (NMQ)
- Summary

Rain Gauge Data

Rain gauge data for National Weather Service (NWS) operations come from several different sources:

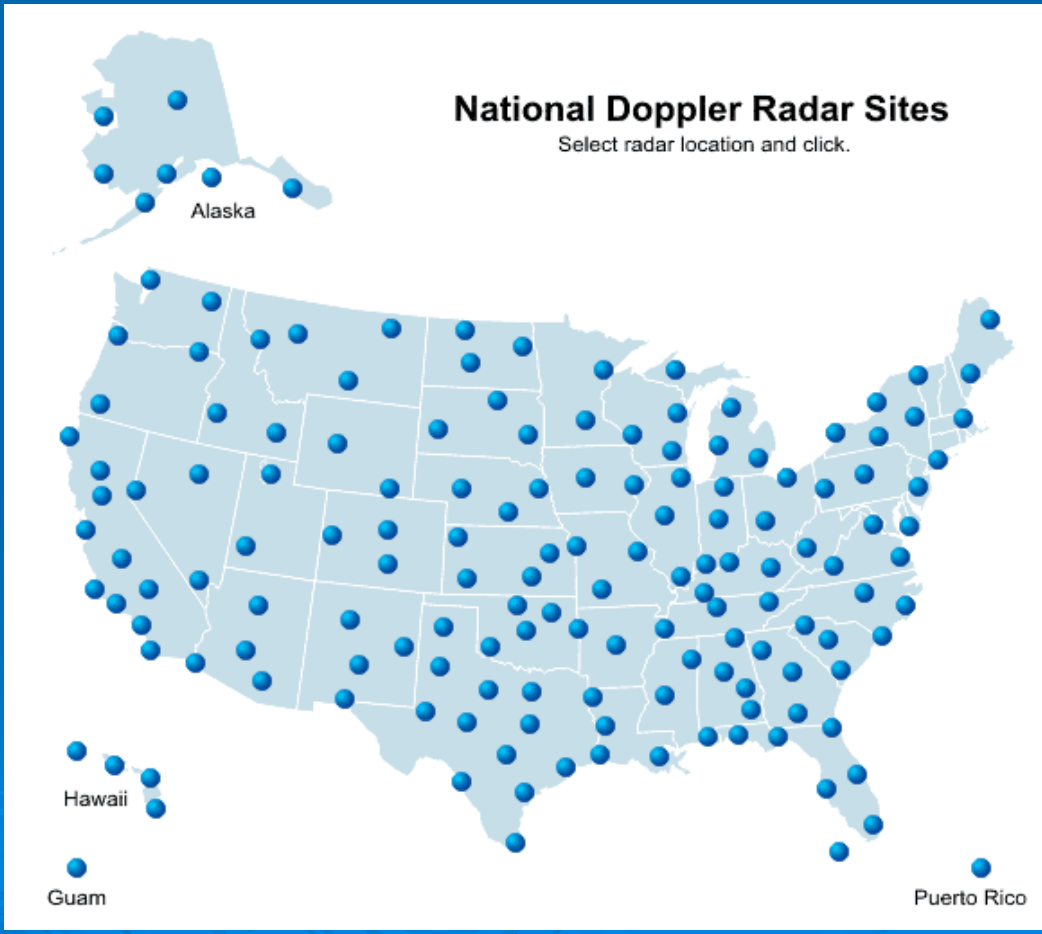
- Hydrometeorological Automated Data System (HADS):
  - Federal & State Wildland Fire Programs --- 2,600 rain gauges
  - USGS --- 1,896 rain gauges
  - USACE --- 1,636 rain gauges
  - NWS --- 252 rain gauges
  - ~120 other DCS Platform operators (USBR, TVA etc.)

Rain Gauge Data (Contd.)

- NWS also receives rain gauge data from other sources:
  - State and local government funded agencies (Mesonets)
  - Automated Surface Observing System
  - Cooperative rain gauge network
  - Other NWS supported gauges (IFLOWS, ALERT etc.)
- Spatial Resolution: Uneven
- Temporal Resolution: Minutes to daily

Radar Rainfall Estimates

- Radar rainfall estimates for the NWS operations come from the WSR-88D radar network (160)
- Temporal resolution: 6 min.
- Spatial resolution: 2Km x 1 Deg



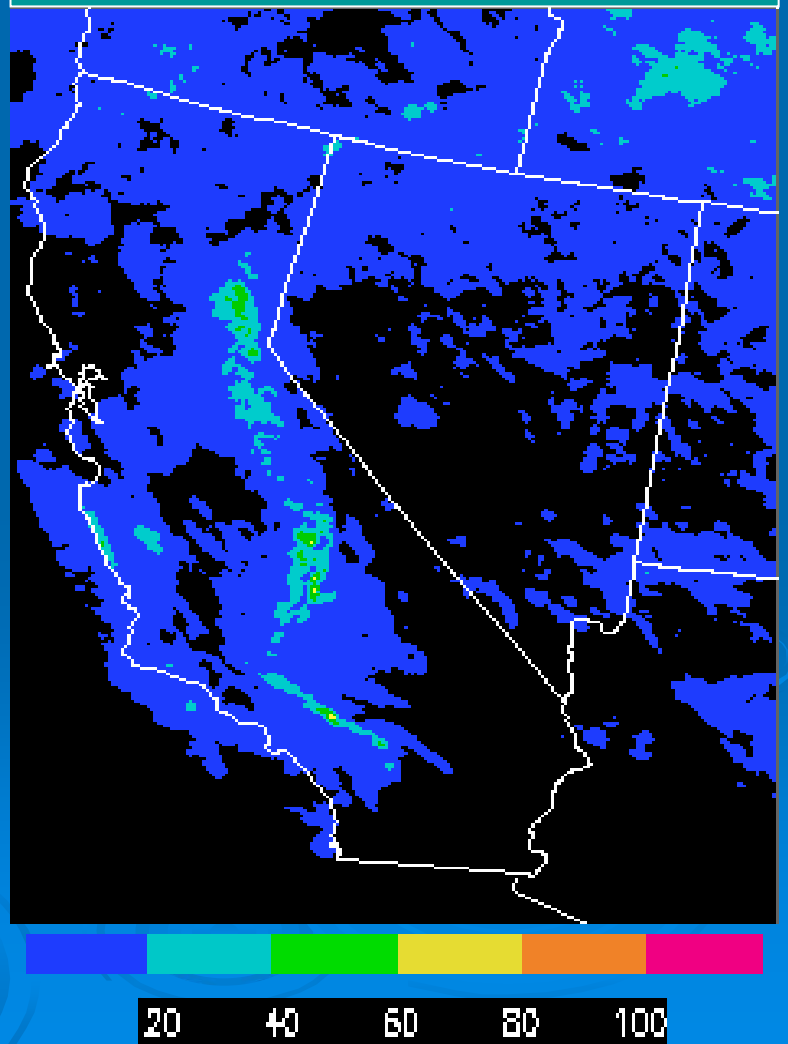
Satellite Precipitation Estimates (SPE)

- Visible / Infrared (IR) based products
  - Hydroestimator
  - GOES Multi Spectral Rainfall Algorithm (GMSRA)
- Microwave (MW) based products
  - SSM/I
  - AMSU-B
- IR + MW combination products
  - Self-Calibrating Multivariate Precipitation Retrieval (SCaMPR)
  - CMORPH (NWS/CPC)

Hydroestimator

- Produced every 15 minutes over the continental United States using GOES-11 and -12 data at 4-km resolution
- Available in real-time from the NESDIS Flash Flood Home page: http://www.orbit.nesdis.noaa.gov/smcd/emb/ff/auto.html
- Also produced in other regions throughout the globe whenever IR imagery is available

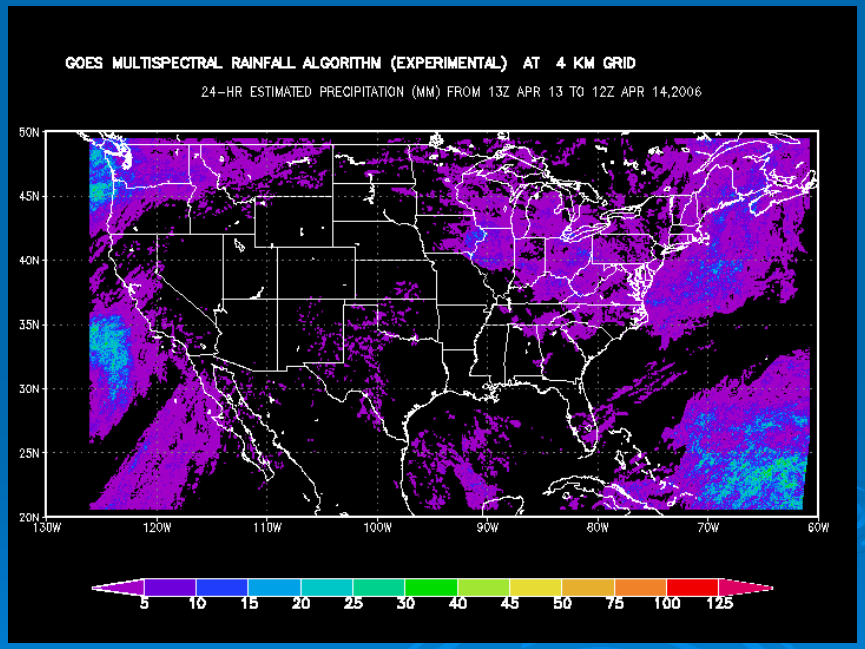
24 Hr Hydroestimator (mm)
Dec 17, 2002



GMSRA

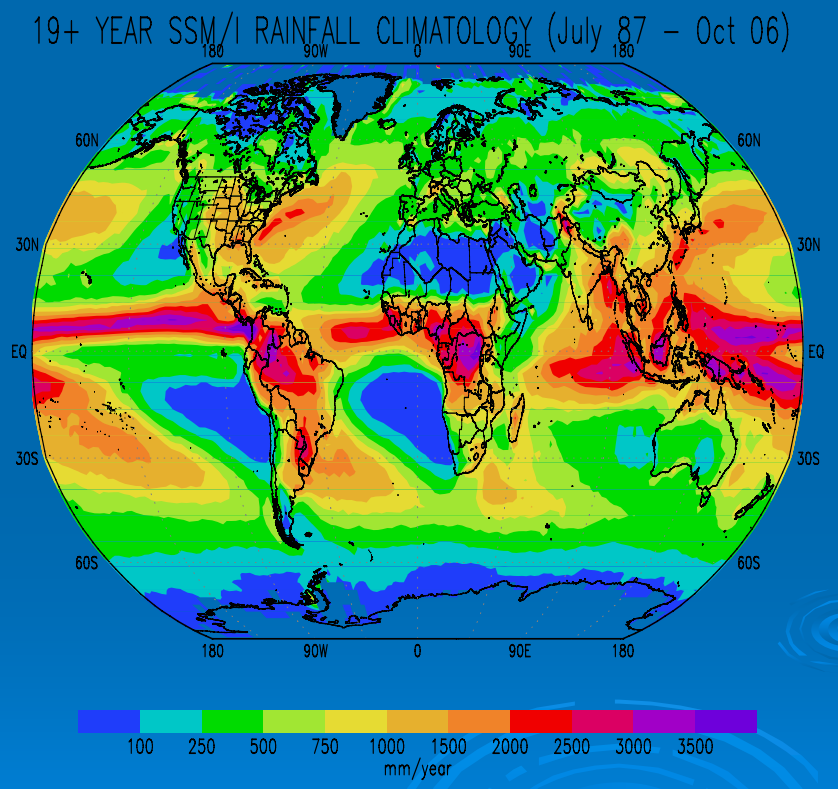
- Produced every 15 minutes for the CONUS and nearby regions using GOES-10 and -12 data at 4-km resolution
- Available in real-time over the Internet at http://www.orbit.nesdis.noaa.gov/smcd/emb/ff/gmsra.html

24-h Total Ending 1200 UTC 14 April 2006



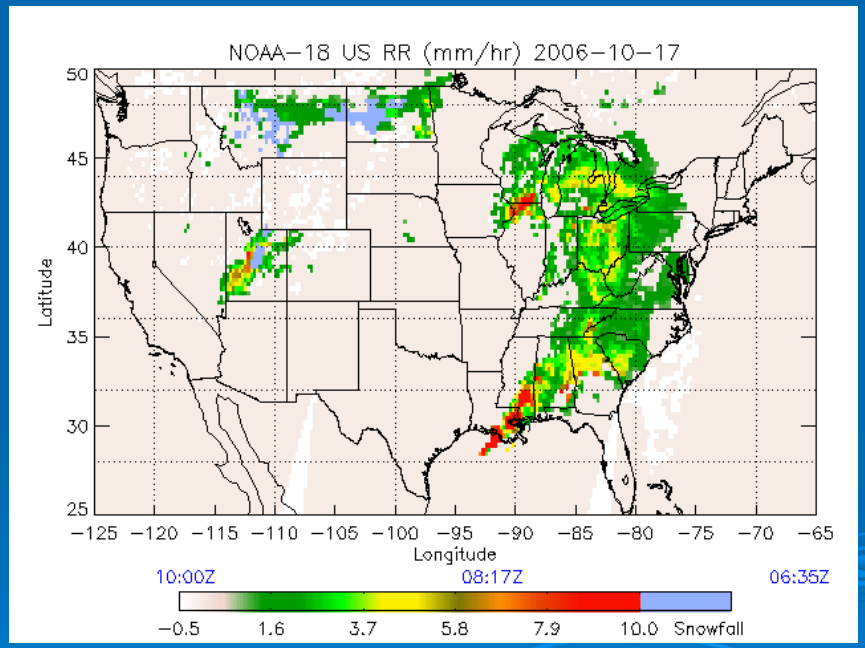
SSM/I Products

- Monthly mean precipitation derived from SSM/I since 1987
- Spatial Resolution= 15km
- Archived at NCDC



AMSU-B Products

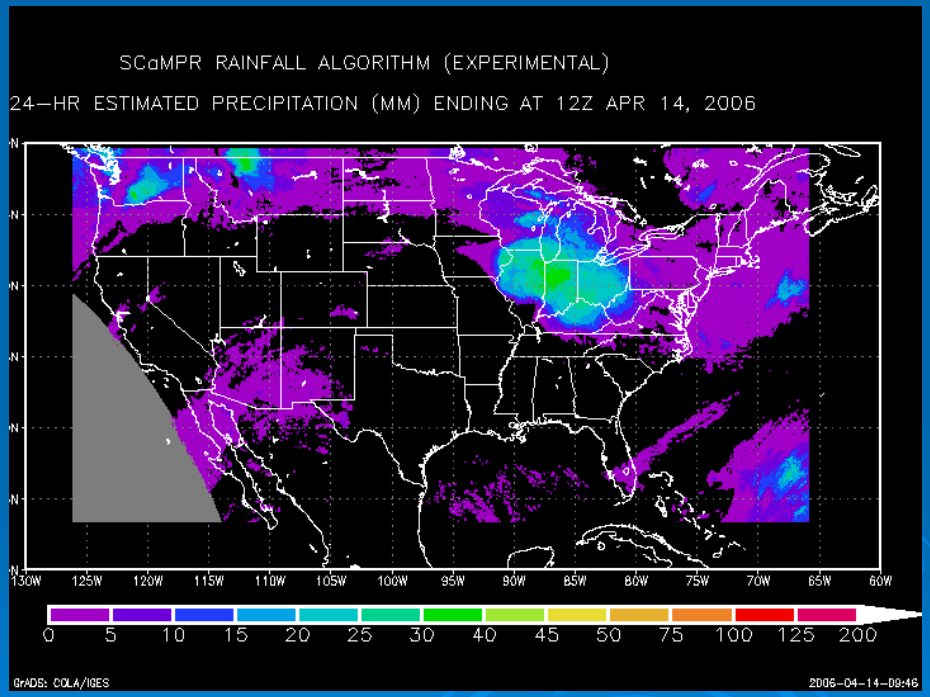
- Operational products from NOAA-15, 16, 17 & 18 AMSU/MHS
  - Precipitation rate
  - Snow cover and water equivalent
- Orbital near real-time products, 5-day and monthly products
- Spatial Resolution = 1/3 deg.



SCaMPR

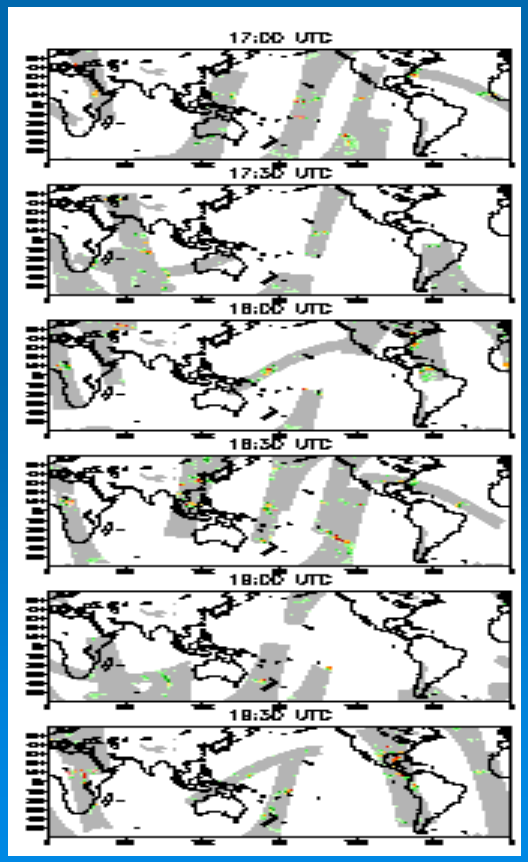
- Self-Calibrating Multivariate Precipitation Retrieval
- Calibrate IR predictors to MW rain rates
- Produced every 15 minutes from 20-55 N and 130-60 W at 4-km resolution
- Available on the Web at http://www.orbit.nesdis.noaa.gov/smcd/emb/ff/scampr.html

24-h Total Ending 1200 UTC 14 April 2006



CMORPH

- Motion field is derived from successive ½ hour IR images from GOES
- Passive MW precipitation field is propagated forward and backward using the motion field to get precip. field between microwave passes
- Temporal resolution = ½ hour
- Spatial Resolution = ~ 8km



Passive Microwave + **Motion from IR** → CMORPH

- TMI (TRMM)
- AMSU-B (NOAA- POES)
- SSMI (DMSP)
- SSMIS (DMSP)
- AMSR-E (Aqua)

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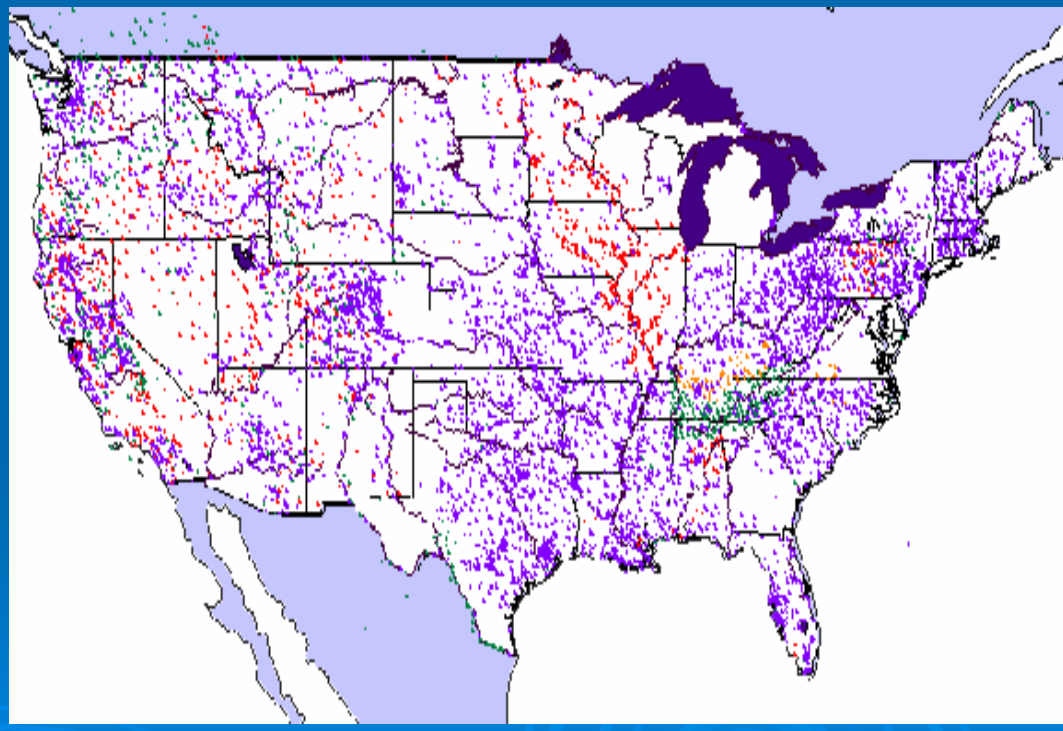
Issues with Rain Gauge Data

- Rain gauge network density is uneven and poor in some parts of the country
- Point sources and do not represent a spatial domain

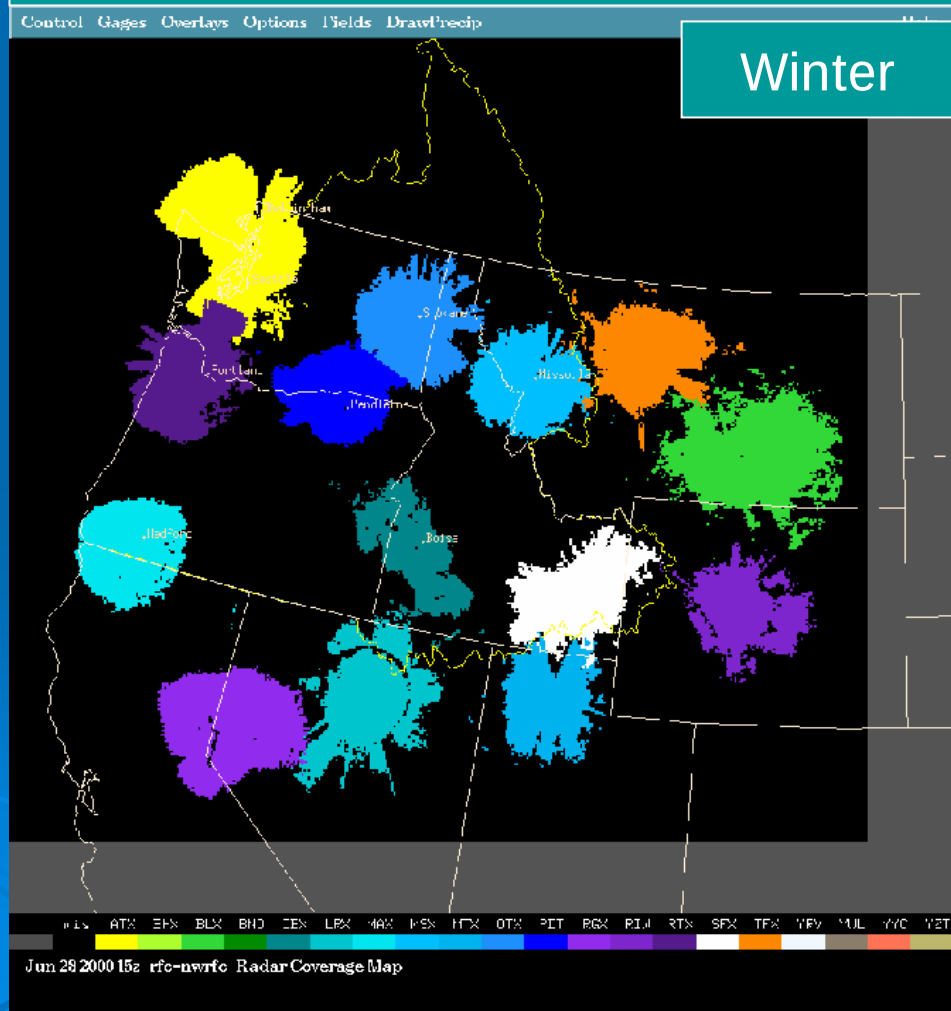
GOES Data Collection Platform Locations



Issues with Radar Data

- Effective radar coverage is the useable part of radar data after accounting for beam blockage and range effects
- Effective radar coverage is poor in the mountainous western US
- Degradation of accuracy of rainfall estimates due to brightband effects

Effective NWRFC Radar Coverage



Issues with Satellite Precip. Estimates

- Vis/IR: Better spatial and temporal coverage, but poor physical connection to precipitation
- MW: Better physical connection to precipitation but poor spatial and temporal coverage
- Combination (IR+MW): Improvement over the above two techniques, but the accuracy is still not good enough for flood forecasting applications

Solution

- Because of the aforementioned issues with each source of precipitation data, NOAA is venturing into multi-platform, multi-sensor precipitation estimation algorithms

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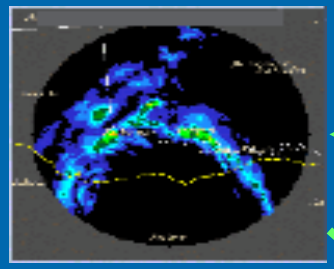
Multi-sensor Precipitation Estimator (MPE)

- Operational precipitation analysis software currently in use at River Forecast Centers (RFC) and Weather Forecast Offices (WFO) of the NWS
- Integrates precipitation information from rain gauges, radars and satellites and generates continuous gridded precipitation fields
  - Mosaics multi radar fields according to lowest elevation angle for an RFC area
  - Corrects for biases in radar and satellite fields
  - Generates multi-sensor gridded precipitation field using Single Optimal Estimation technique
  - Interactive Graphical User Interface (GUI) tools to quality control rain gauge, radar and satellite data
- Temporal Resolution = 1hr
- Spatial Resolution = 4 km

Schematic of Current MPE

DPA



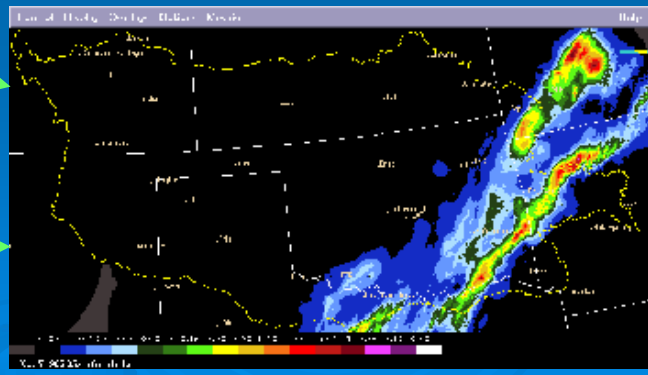
WSR-88D

ORPG/PPS

MeanField / Local Bias Corrrected DPA

Rain Gauges

Multi-Sensor Precipitation Estimator (MPE)



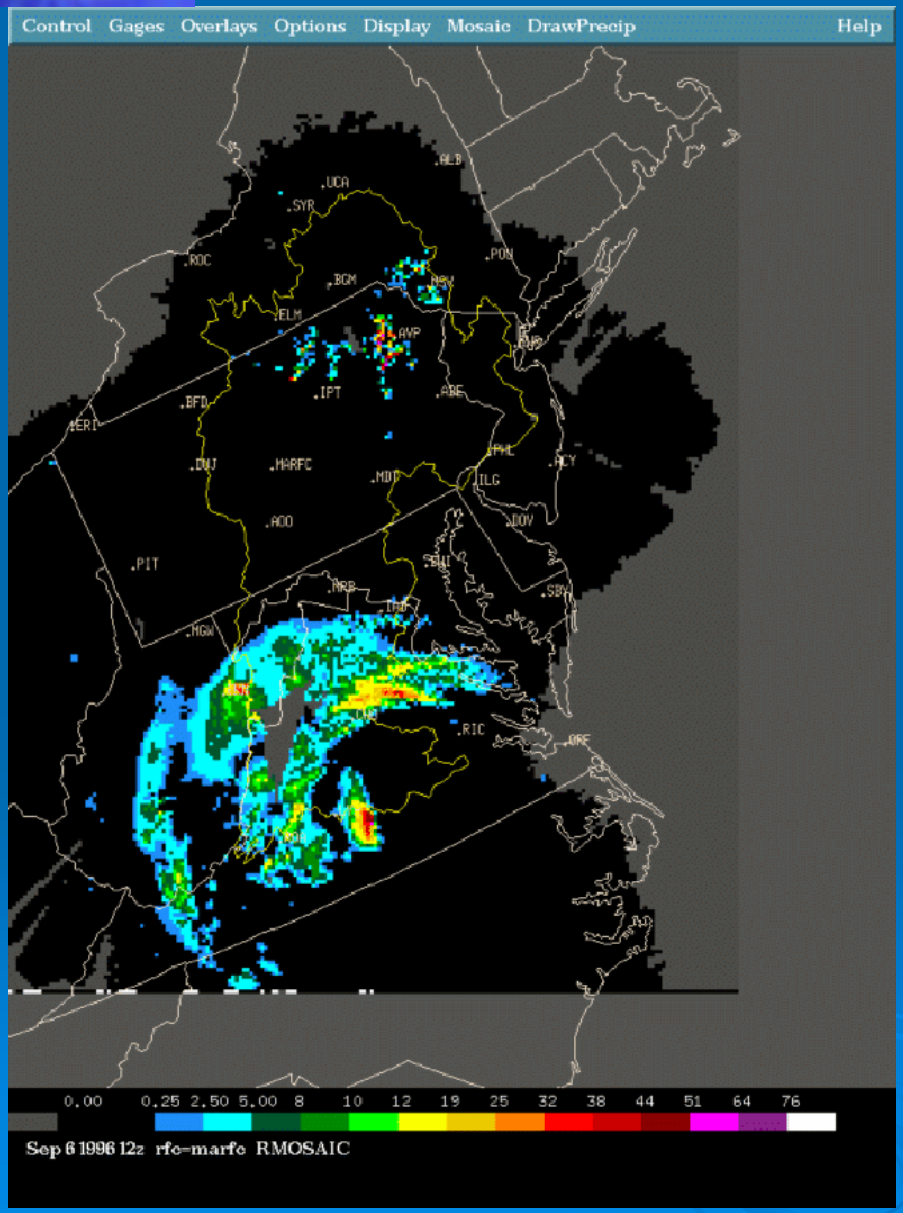
Hydro-Estimator

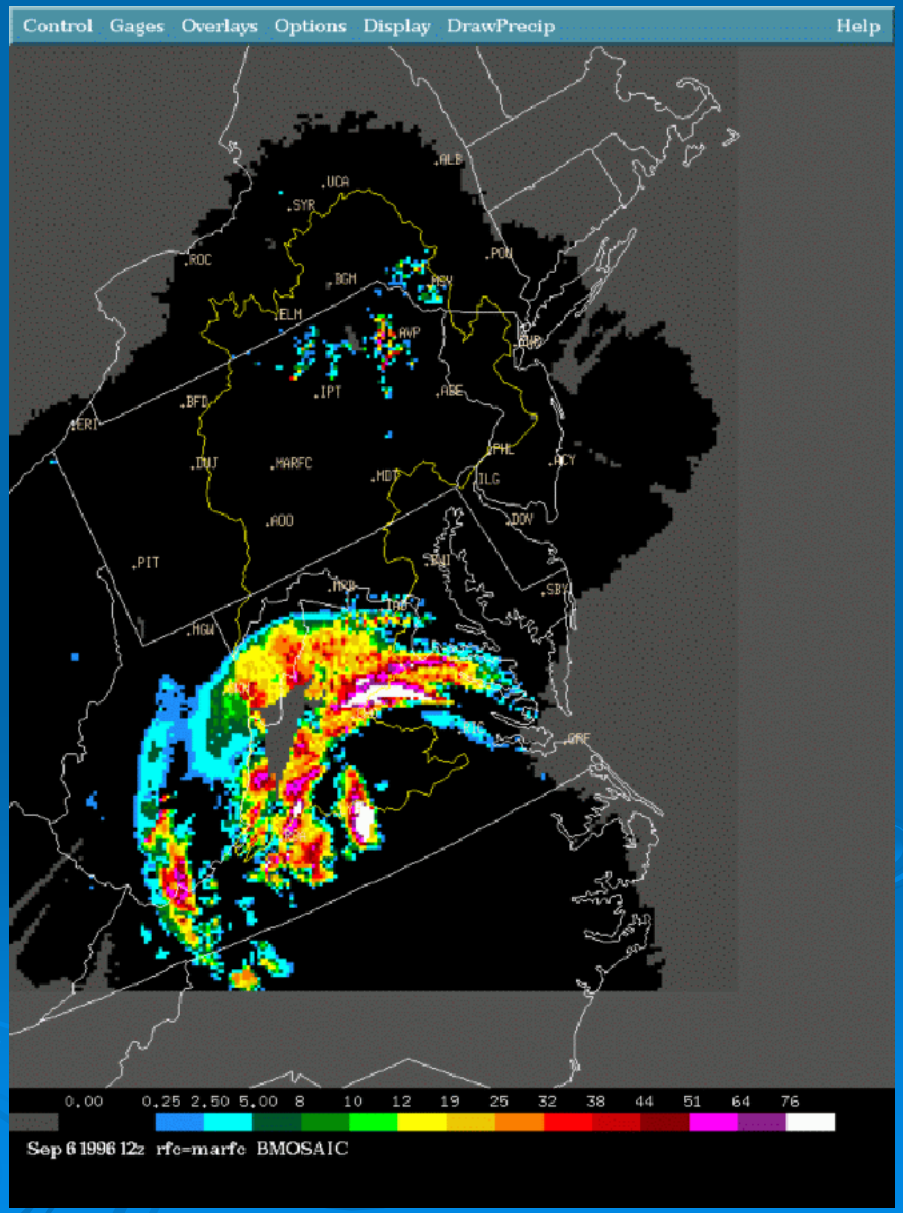
L.B. Cor. HE

GUI (Manual)

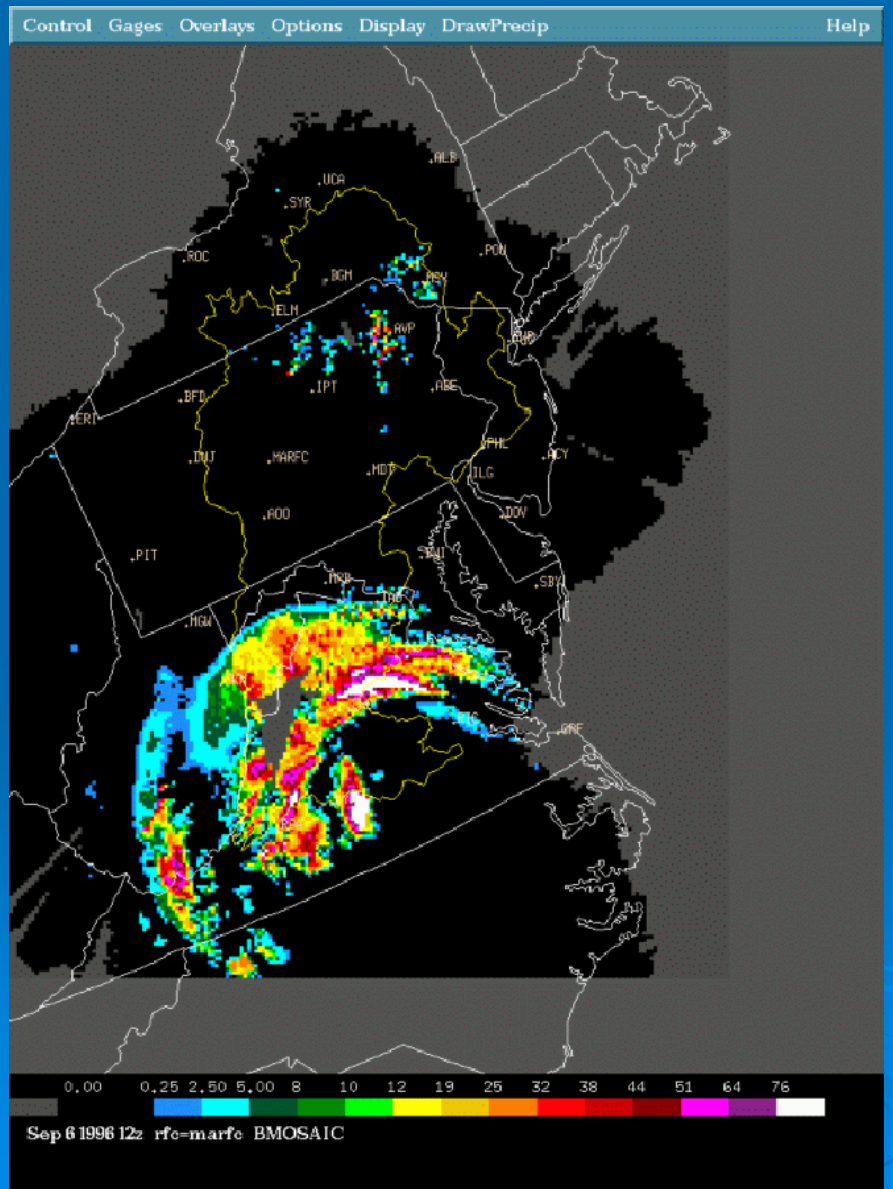
RFC/WFO

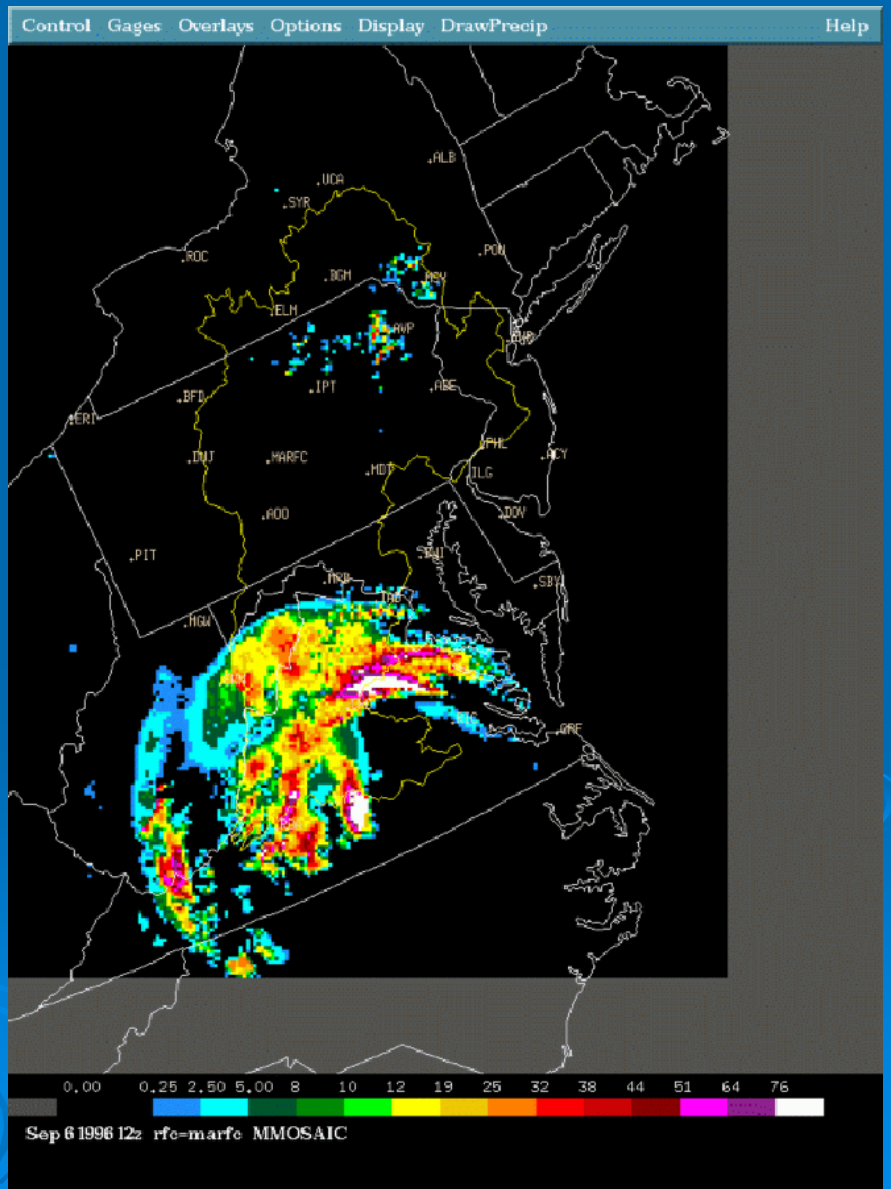
MEAN FIELD BIAS (MFB) ADJUSTMENT in MPE





MULTISENSOR ESTIMATION FILLS MISSING AREAS (MPE)





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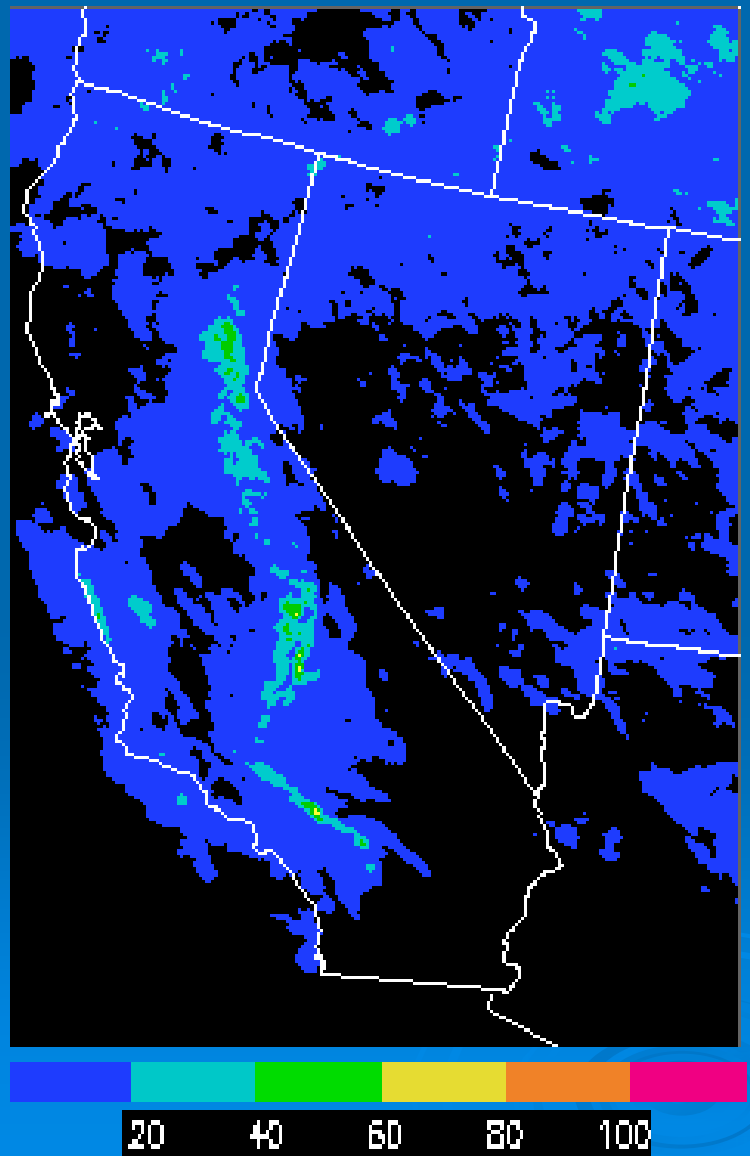
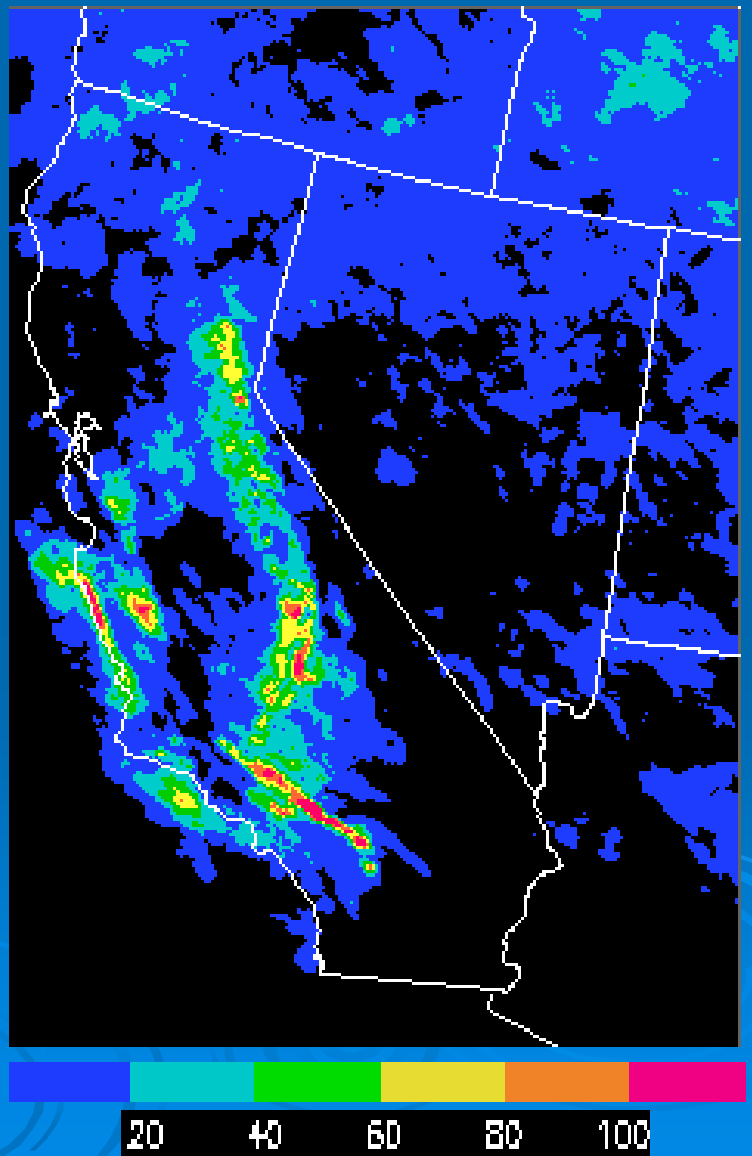
CNRFC 24-Hour Precipitation, 17 Dec 2002

Hydroestimator (mm)

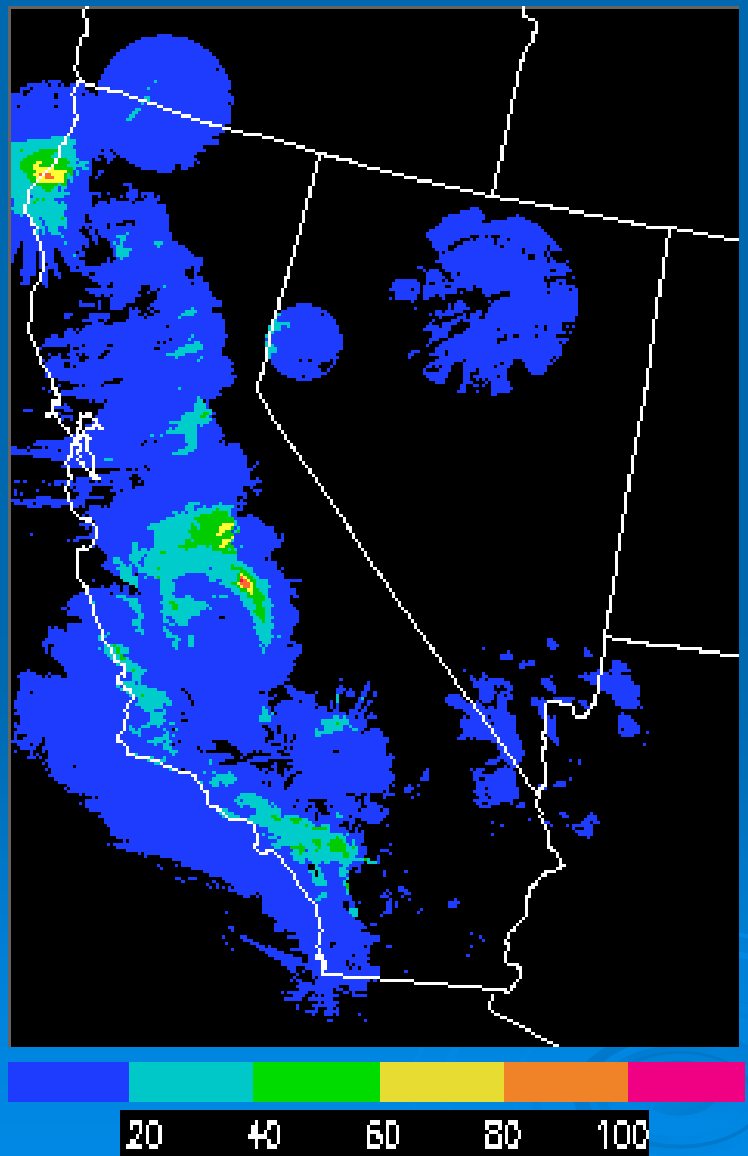


Bias-Corrected Hydroestimator

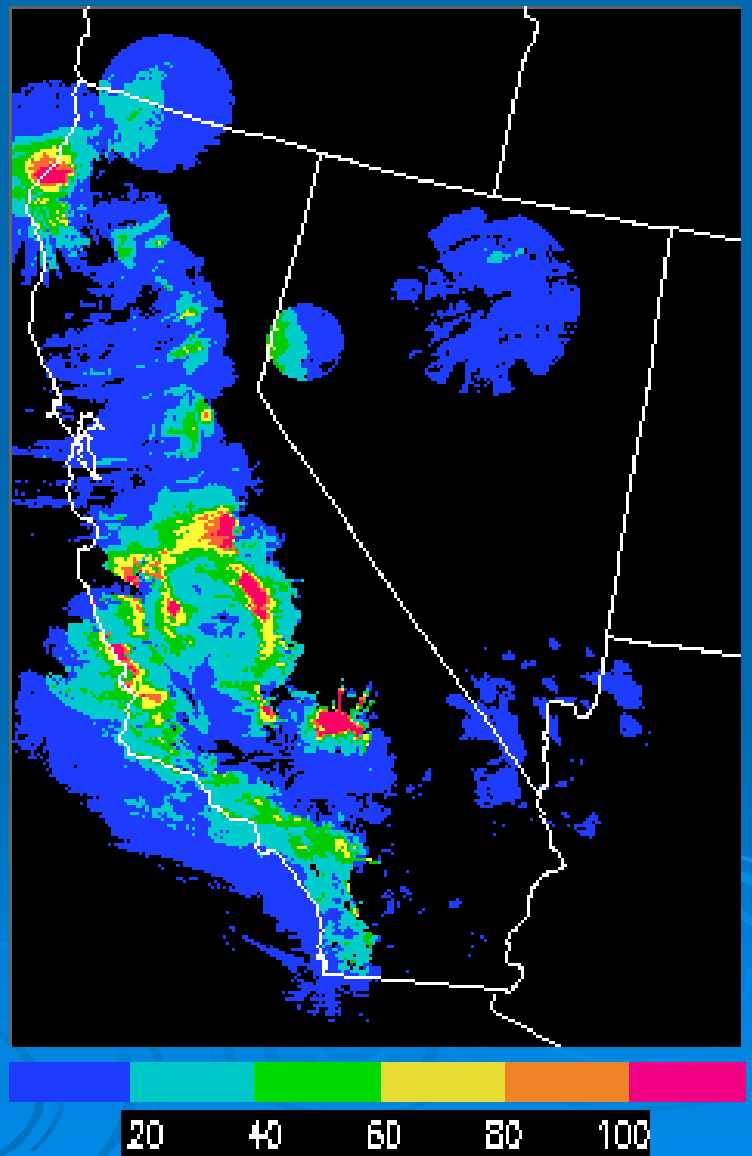


CNRFC 24-Hour Precipitation, Dec 17 Dec 2002

Radar Only

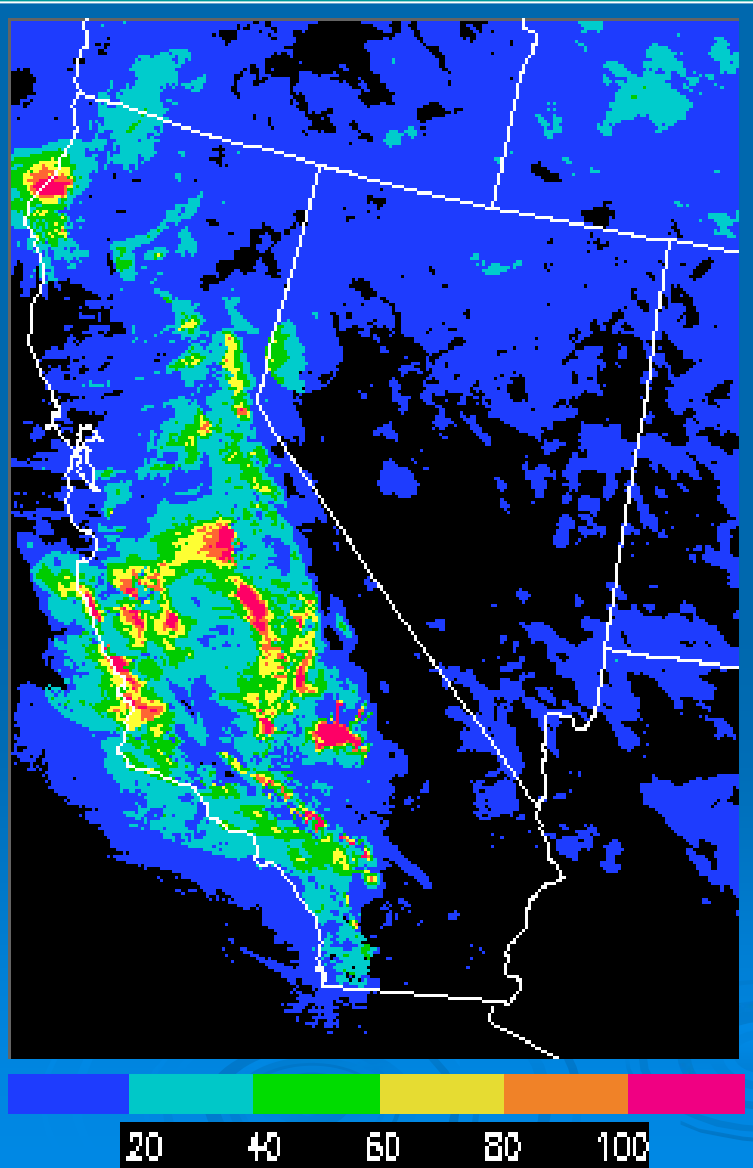


Bias-Corrected Radar



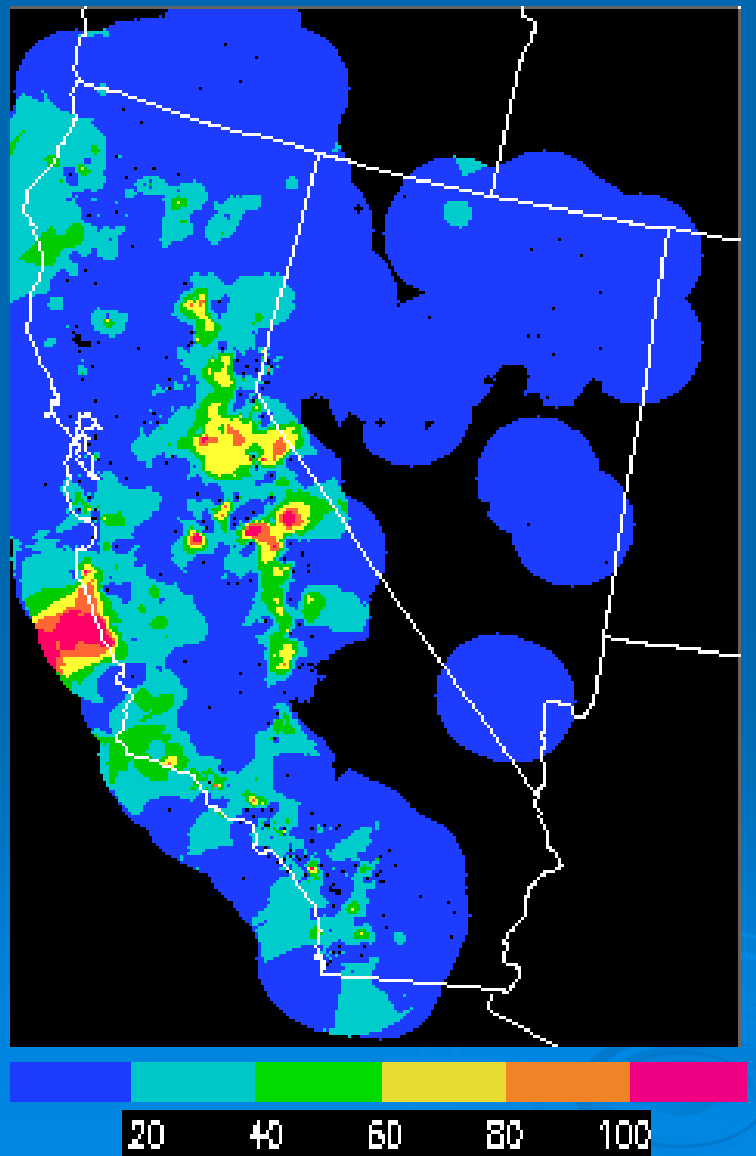
CNRFC 24-Hour Precipitation Dec 17 Dec 2002

Bias-Corrected Radar-Hydroestimator mosaic (mm)

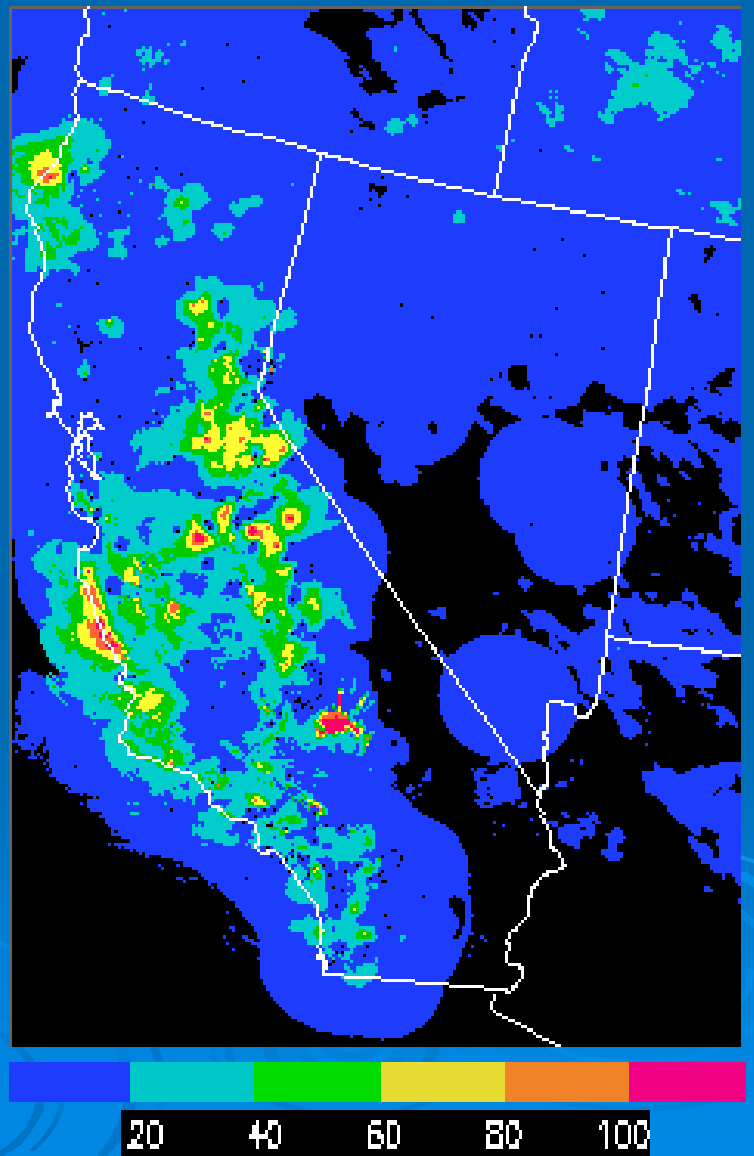


CNRFC 24-Hour Precipitation 17 Dec 2002

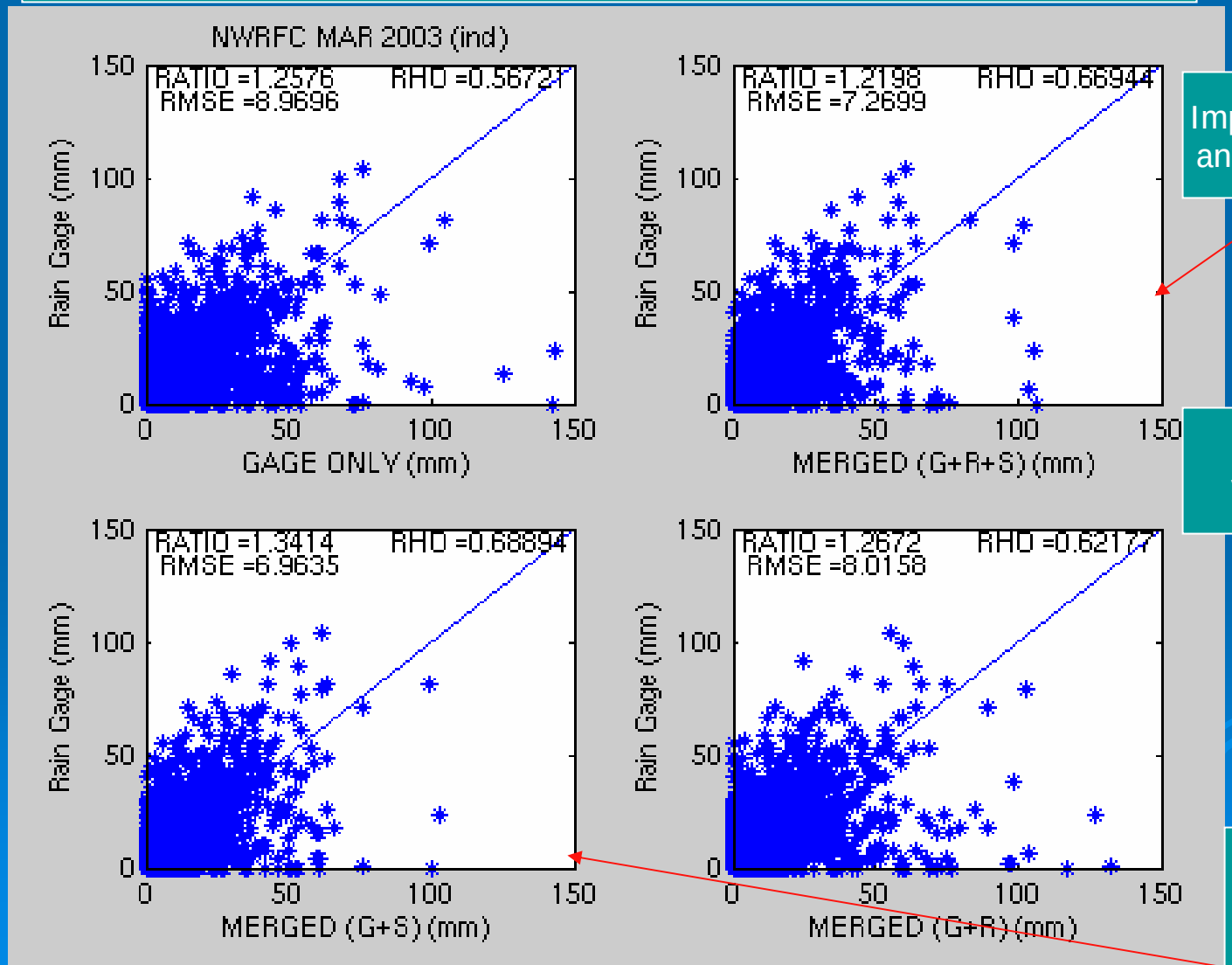
Gauge Only



Gauge-Radar-Hydroestimator



An example of Validation in NWRFC



Improvement over Gauge only and Gauge-radar merged field

Sample size = 8531

Gauge-Hydro merged field better than any other field.

NMQ (Future)

- NMQ (Next-generation Multi-sensor QPE) is a collaboration between NSSL, NESDIS and OHD to determine how best the three sources of information can be combined to improve QPE
- The goal is to produce operational replacement for the MPE product for the NWS applications
- Initial tests over the Tar Basin in North Carolina are currently being planned

Summary

- Individual precipitation sources such as rain gauge, radar and satellite estimates have deficiencies
- Multi-sensor approach was sought as a solution
- Satellite precipitation estimates in conjunction with radar estimates and rain gauge measurements improve quantitative precipitation estimates, especially in the regions where radar coverage is poor and rain gauge density is sparse

Questions ?