



The National NWS QPF Verification Program

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COMET RFC/HPC Hydromet 01-1 Course

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Introduction

- “Verification of direct NWP model, statistical, and forecaster value-added QPFs and PoPs is *necessary* to quantify and improve the skill of QPF/PQPF and PoP forecasts, and to assess the value-added to these forecasts at each step of the NWS [End-to-End] Forecast Process.” - Office of Meteorology (1999)
- “One of the most important components of an effective national QPF program is a comprehensive objective comparative verification system” - National Weather Service (1999)

Outline

- QPF Verification

Subjective - visually compare area/pattern/magnitude of observed to forecast precipitation

Model Biases - forecaster experience

Comparison Plots

Objective - comparative quantitative statistics (measures of bias, accuracy, and/or skill) to assess the quality (degree of correspondence) of QPFs (Katz & Murphy 1997)

HPC QPF Verification

The National Precipitation Verification Unit (NPVU)

Subjective Verification

- The NWP models (Eta, AVN/MRF) have been upgraded often over the past few years
- Thus, it has been difficult to isolate consistent biases across model upgrades

Model QPF Biases

by HPC

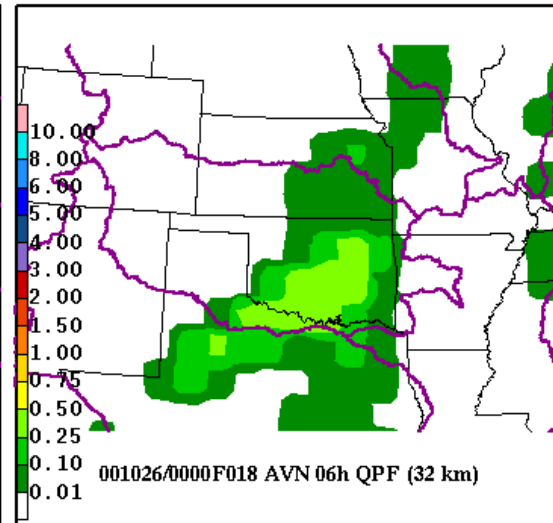
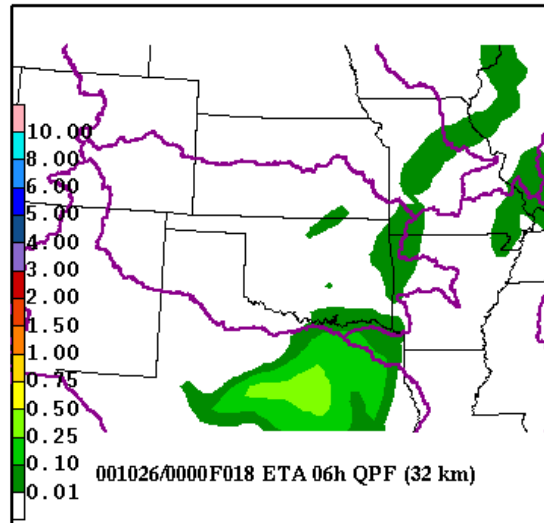
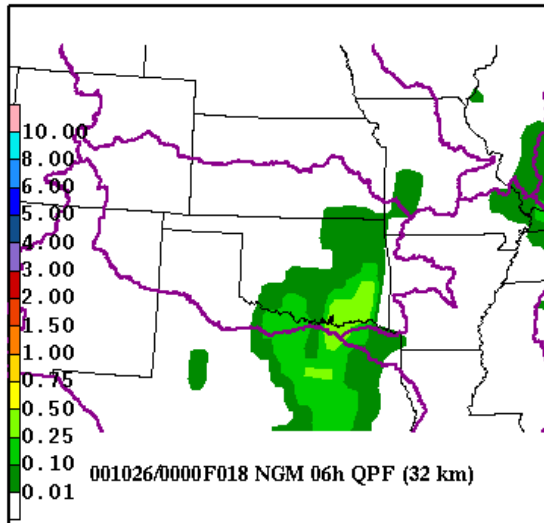
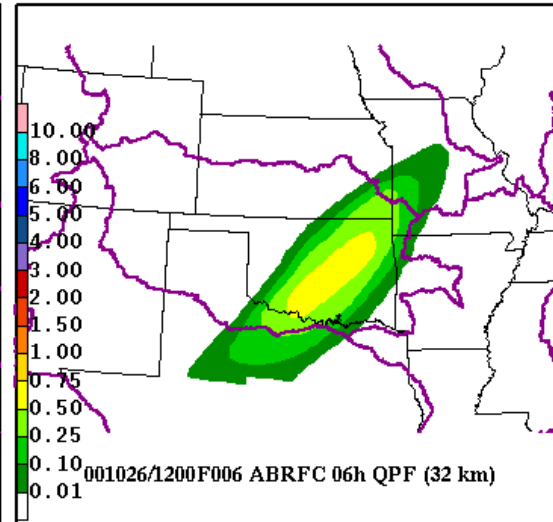
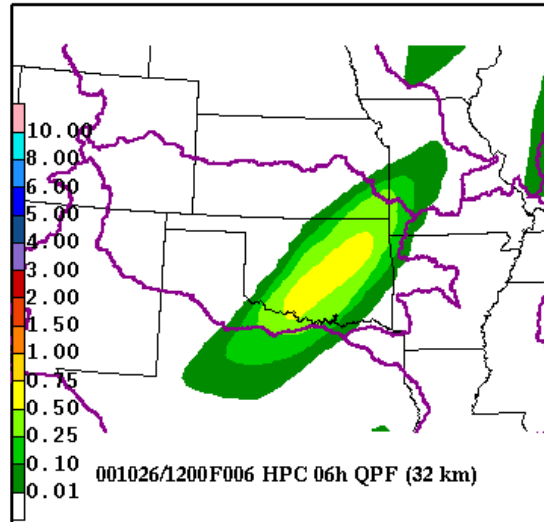
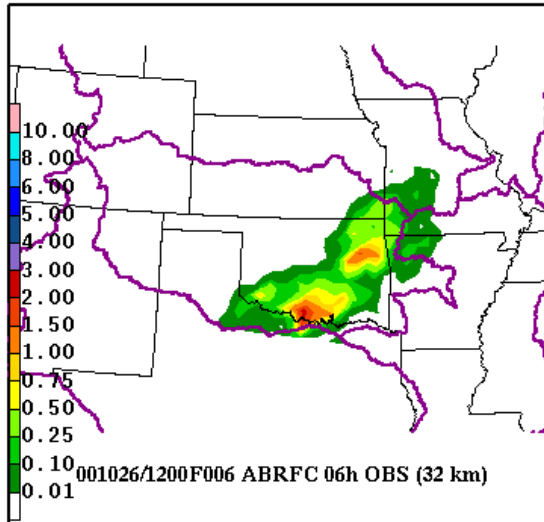
- AVN convective feedback problems (primarily late spring / early summer)
 - AVN produces too much QPF in cold air during either overrunning or precipitation wrapping around back side of non-oceanic lows
 - AVN QPF amounts better than Eta in cool season
 - Eta is generally too dry with convection and AVN too wet in warm season
 - Eta QPF better depiction of convection than AVN in warm season
 - Eta too dry in US SW during monsoon season
 - Eta spreads out lake effect precipitation too much
-
- Although both models show little difference in the mass fields during the warm season, MAJOR differences in QPF are still noted. These differences arise from how convection is parameterized in each model.

Model QPF Biases (cont.)

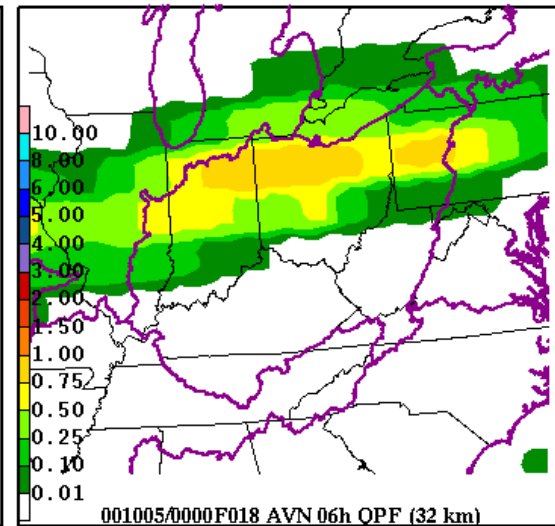
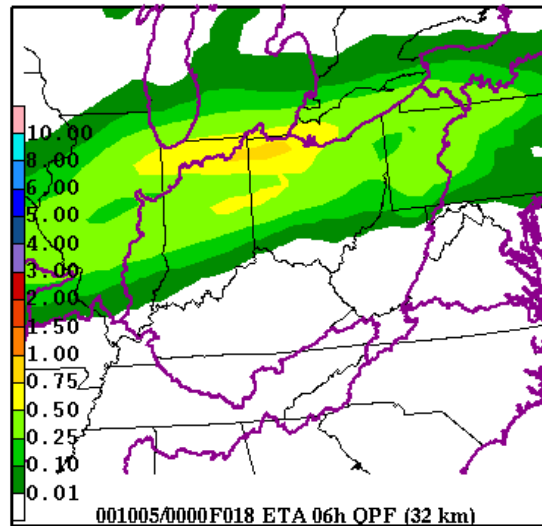
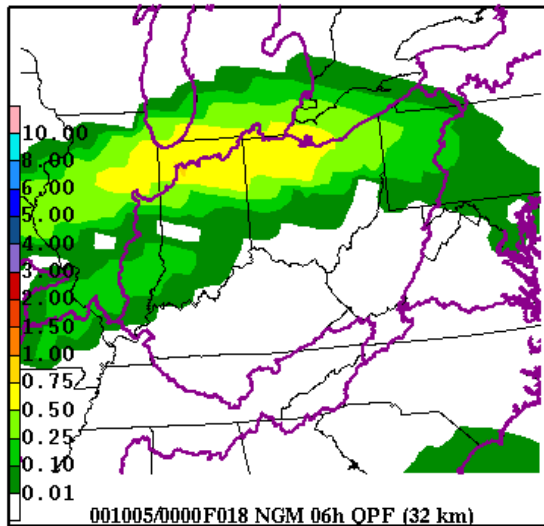
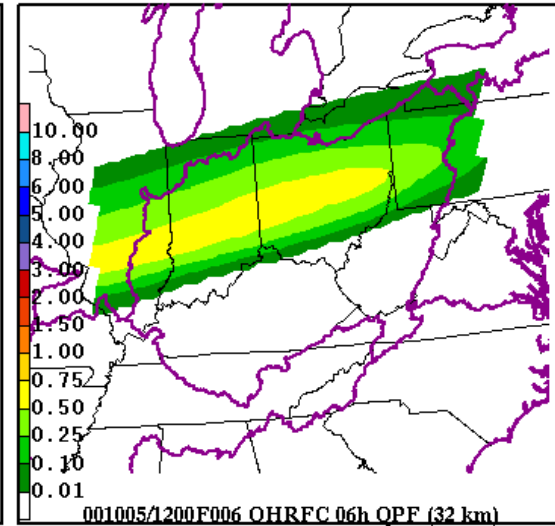
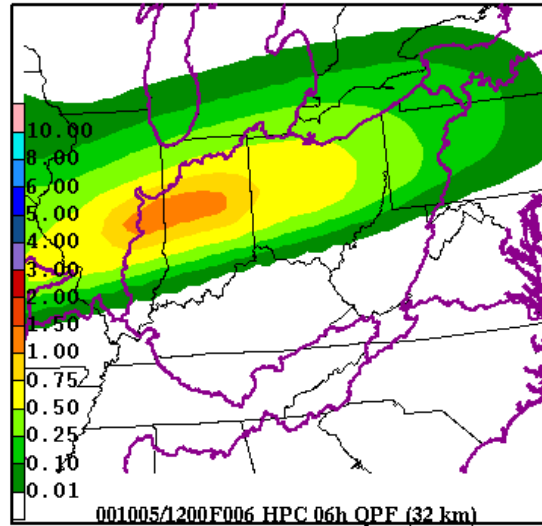
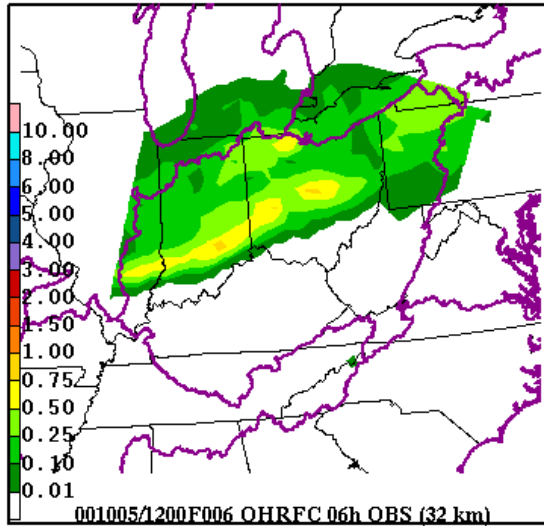
22km Eta, warm season

- Eta22 does a better job picking up on MCC/MCS events than Eta32
- No convective feedback problems
- Eta22 tends to forecast well small-scale precipitation events in the short range for both heavy and light events
- Does not depict a large enough area of precipitation (seems to be dry around the core of a precipitation area associated with strong forcing mechanisms)
- Eta22 seems a little dry with smaller scale convection associated with weak forcing mechanisms
- Tendency to generate too many light amounts of spotty precipitation near terrain in a moist environment (i.e., the Appalachians)
- Eta22 tends to be too far north with nocturnal convection

Comparison Plots



Comparison Plots (cont.)



Objective Verification

- HPC QPF Verification

 - 06-hour QPF Verification

 - Point verification system

 - As of Jan. 1999, no high quality CONUS 06-hour gridded precipitation analysis existed

 - Uniformly distributed (almost) 600+ METAR obs over CONUS

 - OBS points QC'd by HPC forecasters - have opportunity to modify OBS or designate as missing by comparing reports with EMC Stage IV multi-sensor precipitation estimates

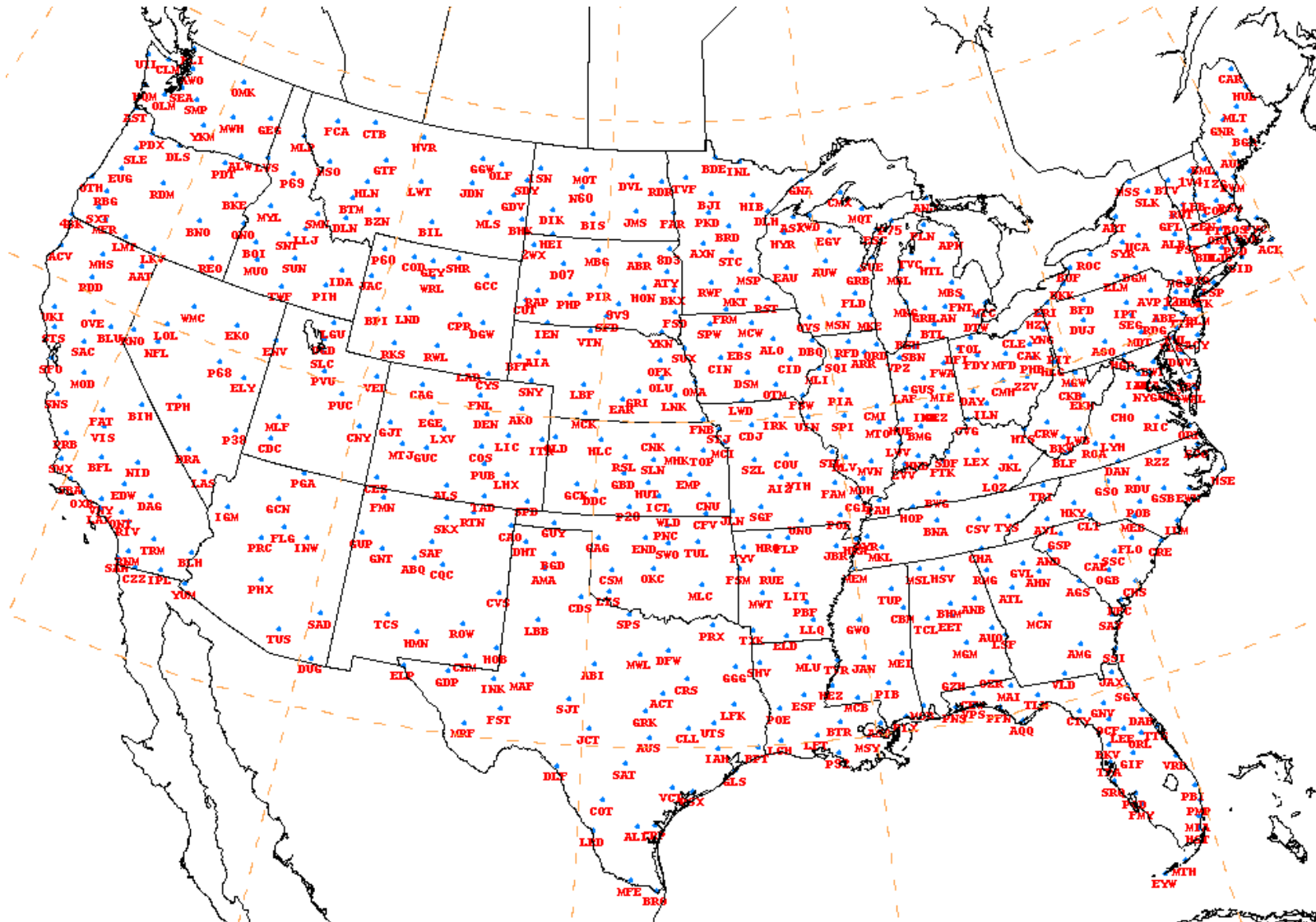
 - Concentrate on 0.25" and above - problems with ASOS precipitation reports

 - Convert All QPFs (HPC, Eta, NGM, AVN, MM5, RUC2) to points via bilinear interpolation

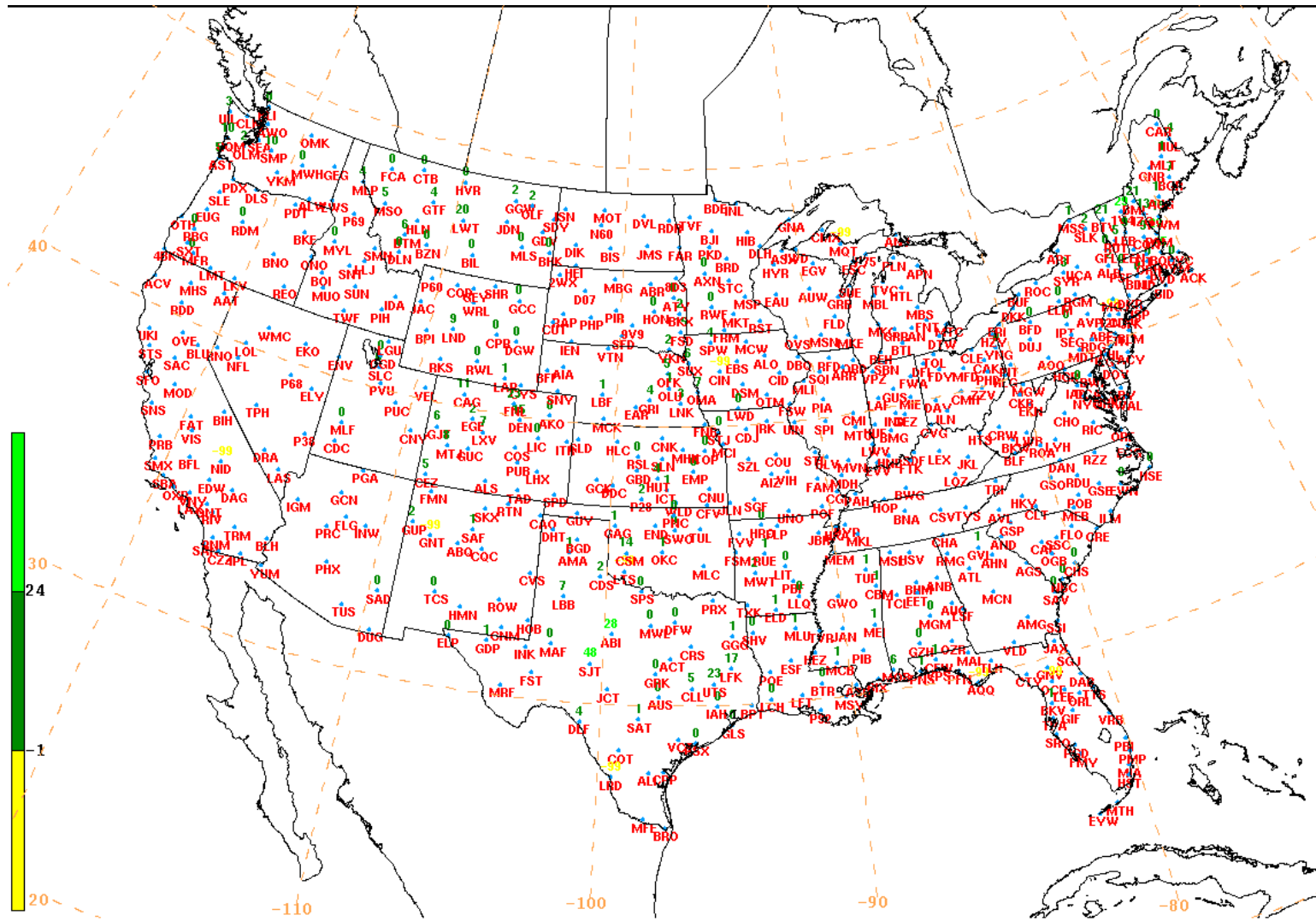
 - Compute Threshold Statistics beginning at 0.25"

 - Threat Score, Bias Score, POD, FAR, ETS

HPC QPF Verification (cont.)

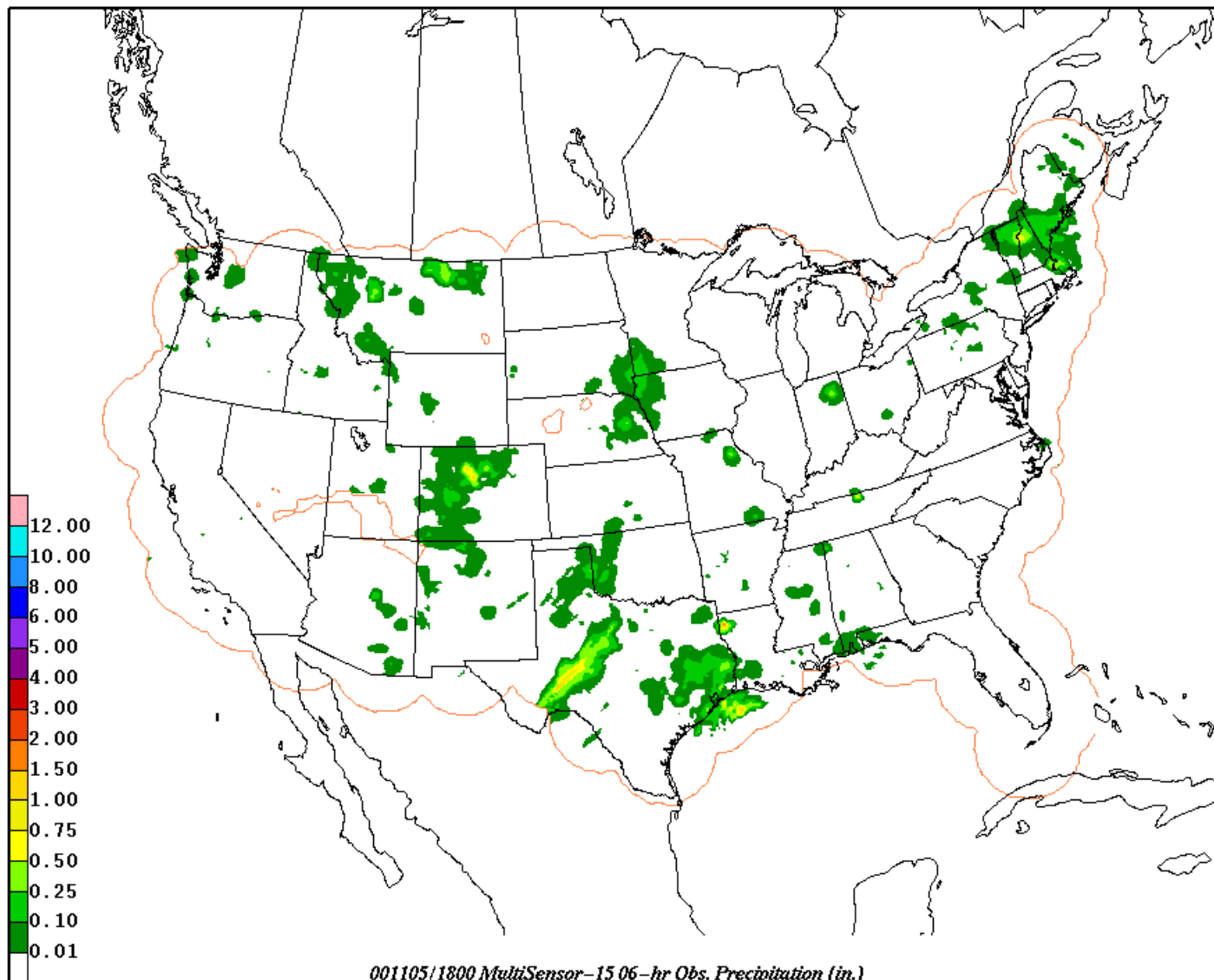


HPC QPF Verification (cont.)



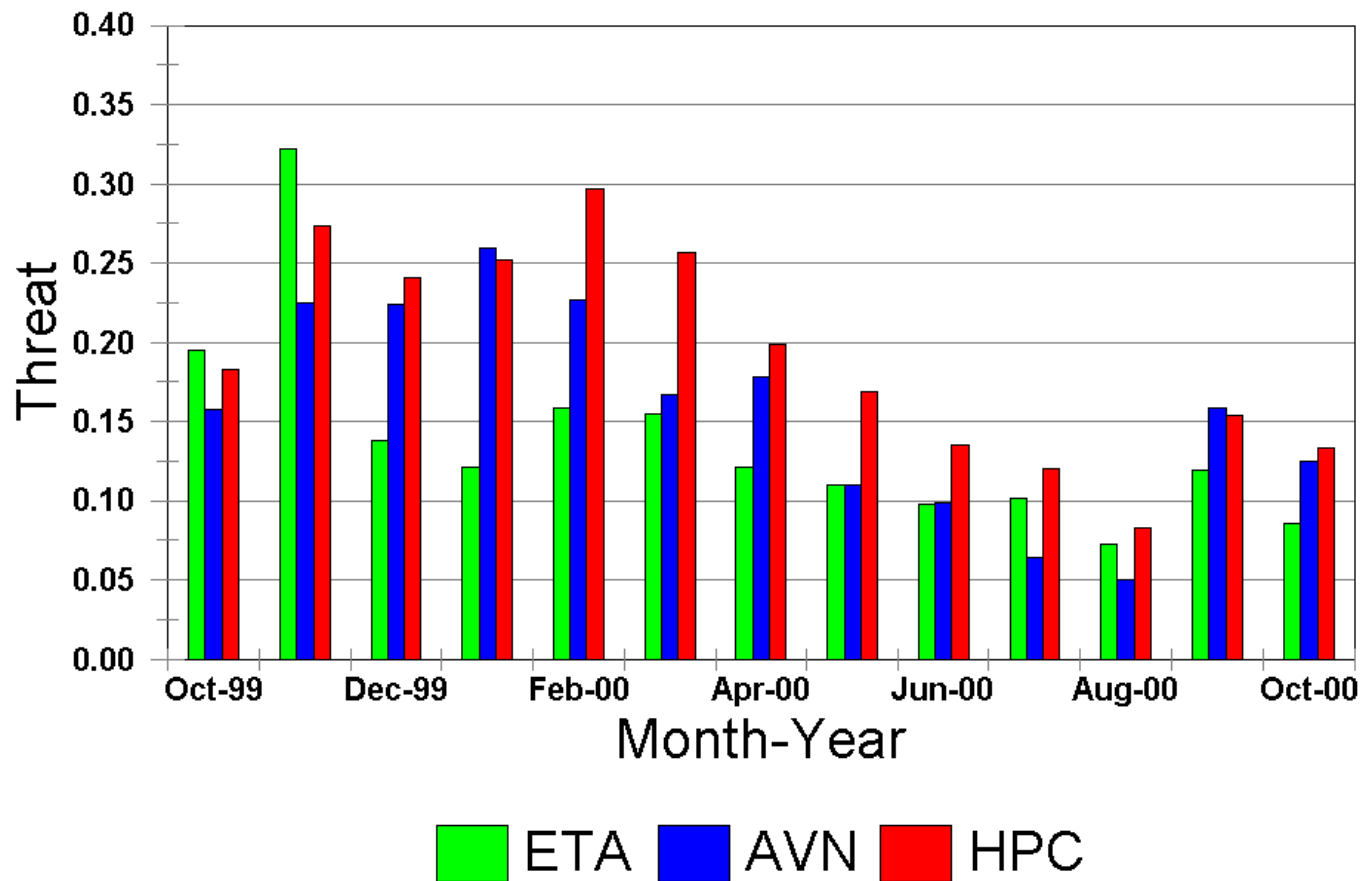
OBS6 001105/1800 MARK P06I*100. STID

HPC QPF Verification (cont.)



HPC QPF Verification (cont.)

.50" HPC -vs- NWP Guidance Threat 6-12 Hour Forecast



HPC QPF Verification (cont.)

24-hour QPF Verification - 30+ years

Gridded verification system

Up until Dec. 1998, Polar Stereographic **30 km** Grid with normalization
Since Jan. 1999, Lambert Conformal **32 km** Grid with normalization
CONUS land areas

First Guess Analysis Field

24-hour gauge-only precipitation observations on IBM SP
EMC Stage III analysis algorithm on 4 km national grid
Remap 4 km grid to 32 km grid

HPC Manual Modification of First Guess using 24-hr gauge observations

CPC data - HYD bulletins, STP Summaries, etc.
METAR & SYN OBS
CNRFC & NWRFC QC'd obs
Analyze 0.50", 1.00", 2.00", etc. contours

HPC QPF Verification (cont.)

Convert Final Analysis to 32 km Verification Grid

NAWIPS “Graph-to-Grid”

Remap All Forecast Products to 32 km Verification Grid

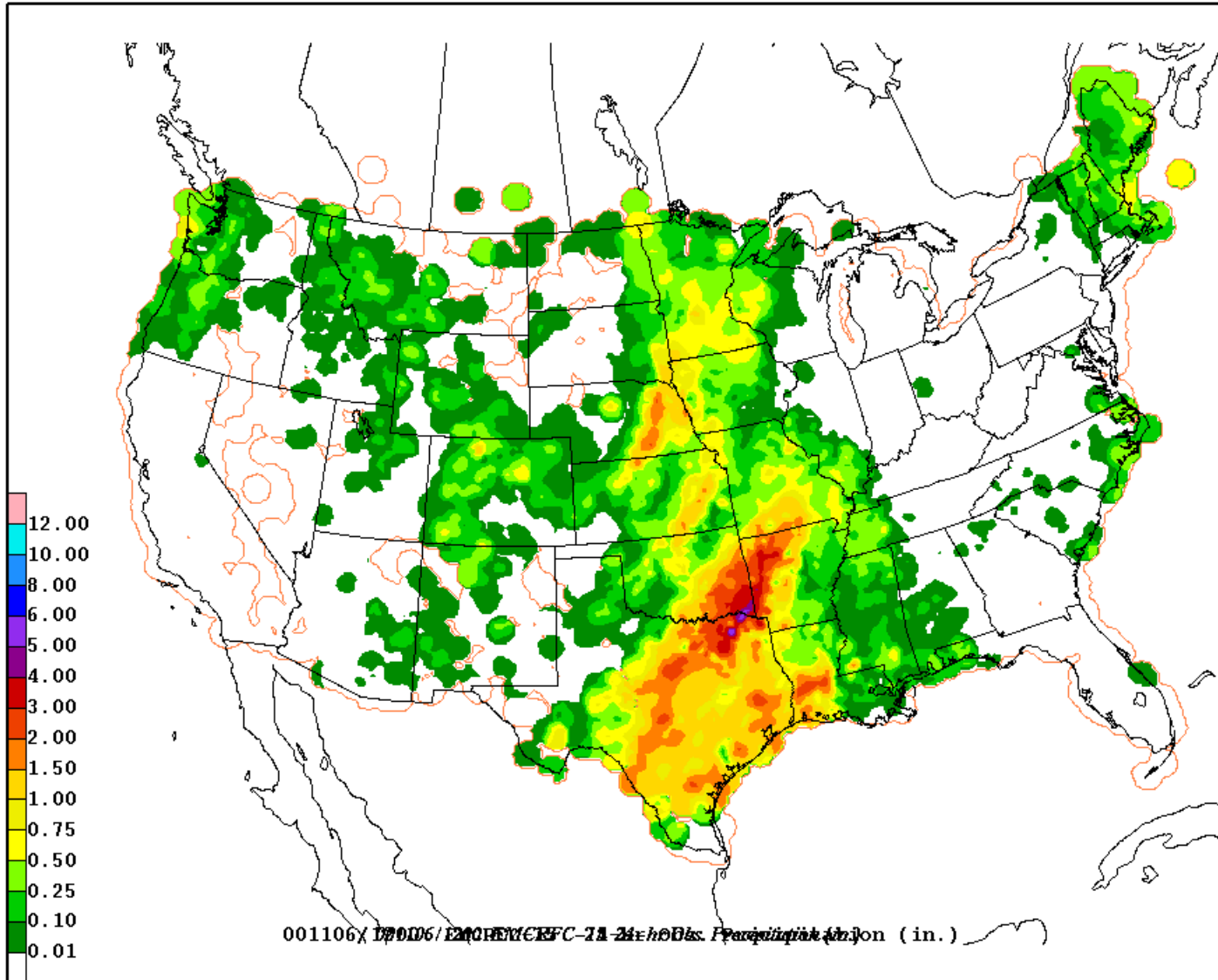
HPC, Eta, NGM, AVN, EtaKF, MM5

Area-Preservation Technique (EMC - Mesinger, Baldwin)

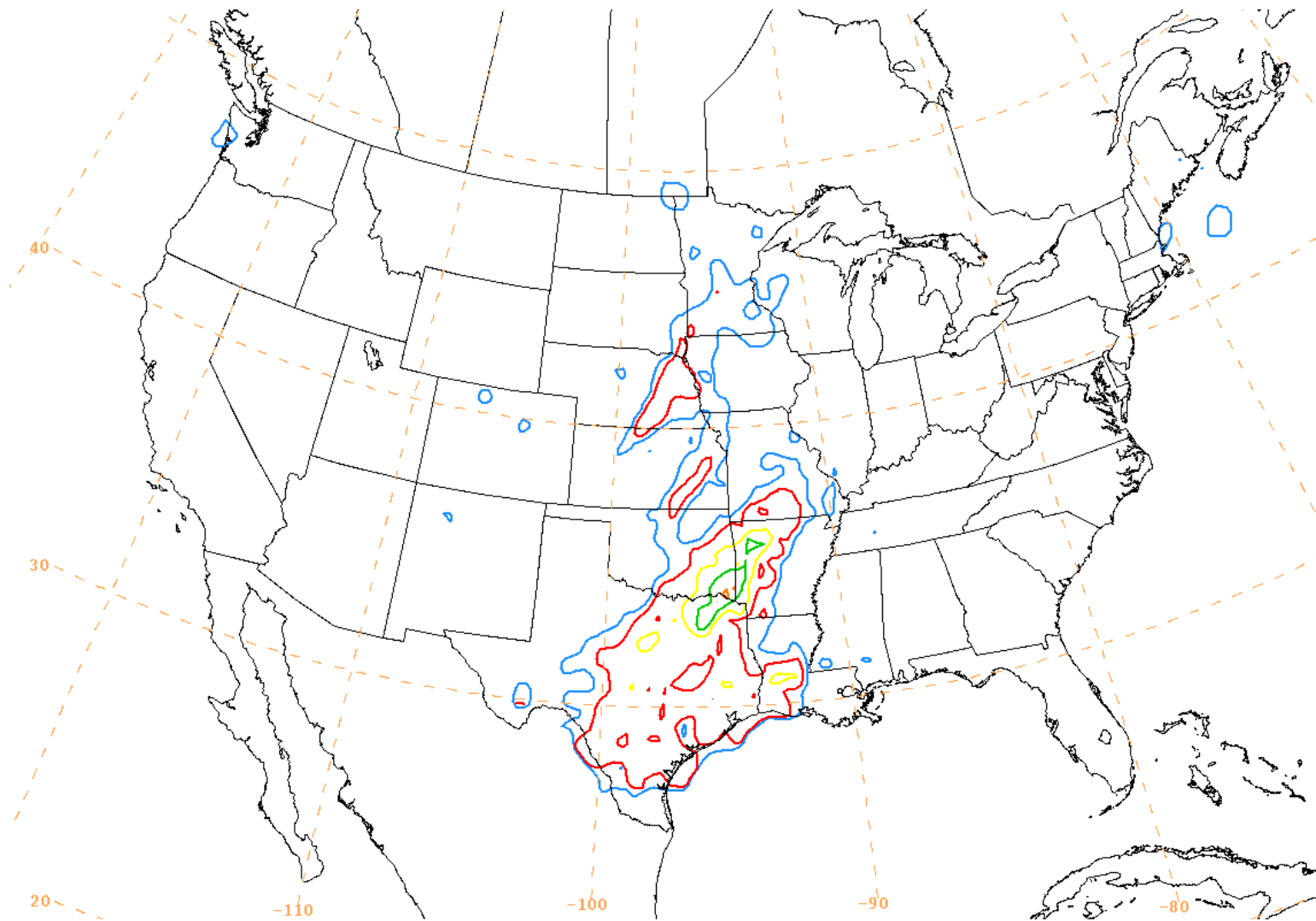
Compute Threshold Statistics beginning at 0.50”

Threat Score, Bias Score, POD, FAR, ETS

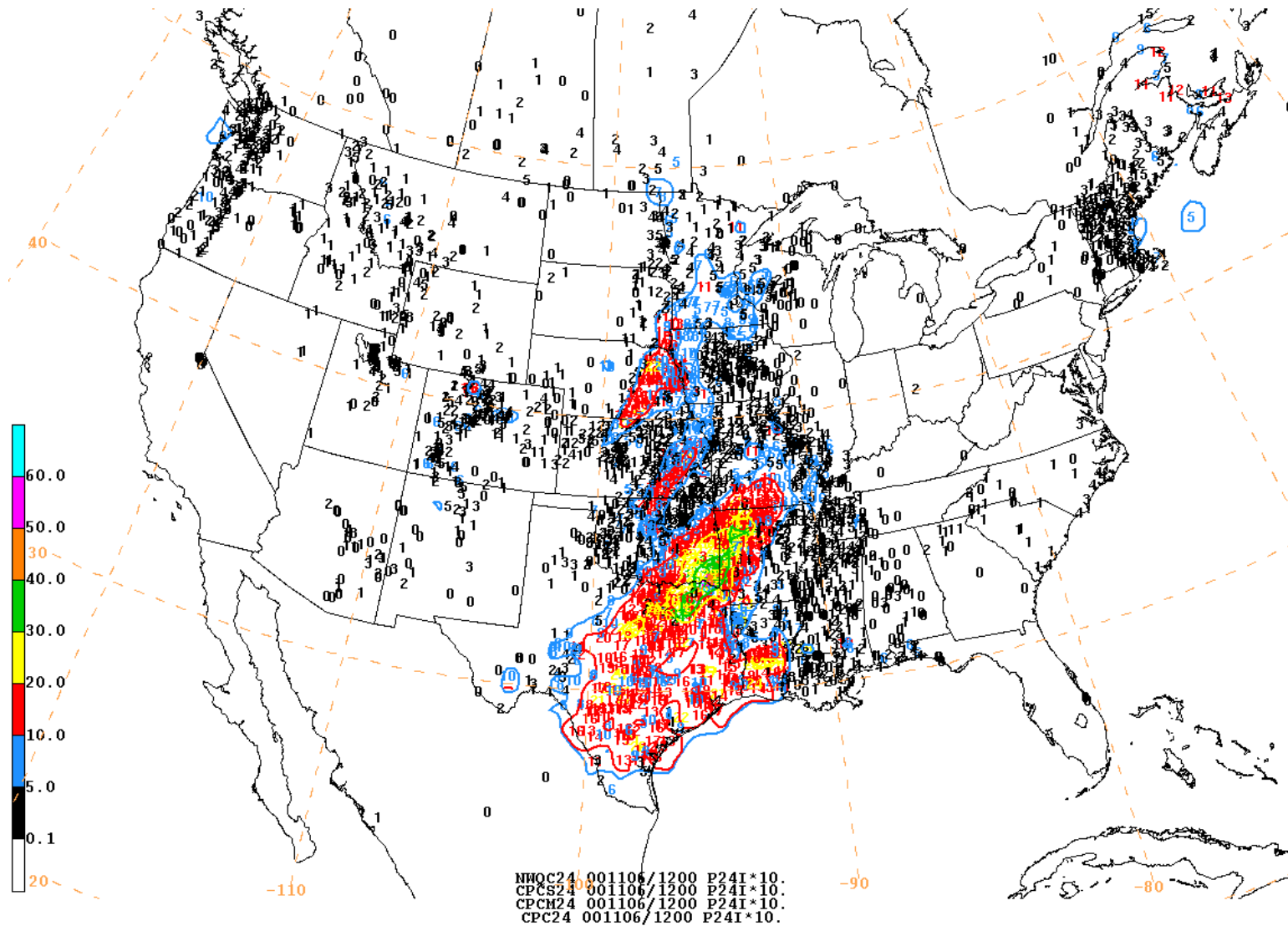
HPC QPF Verification (cont.)



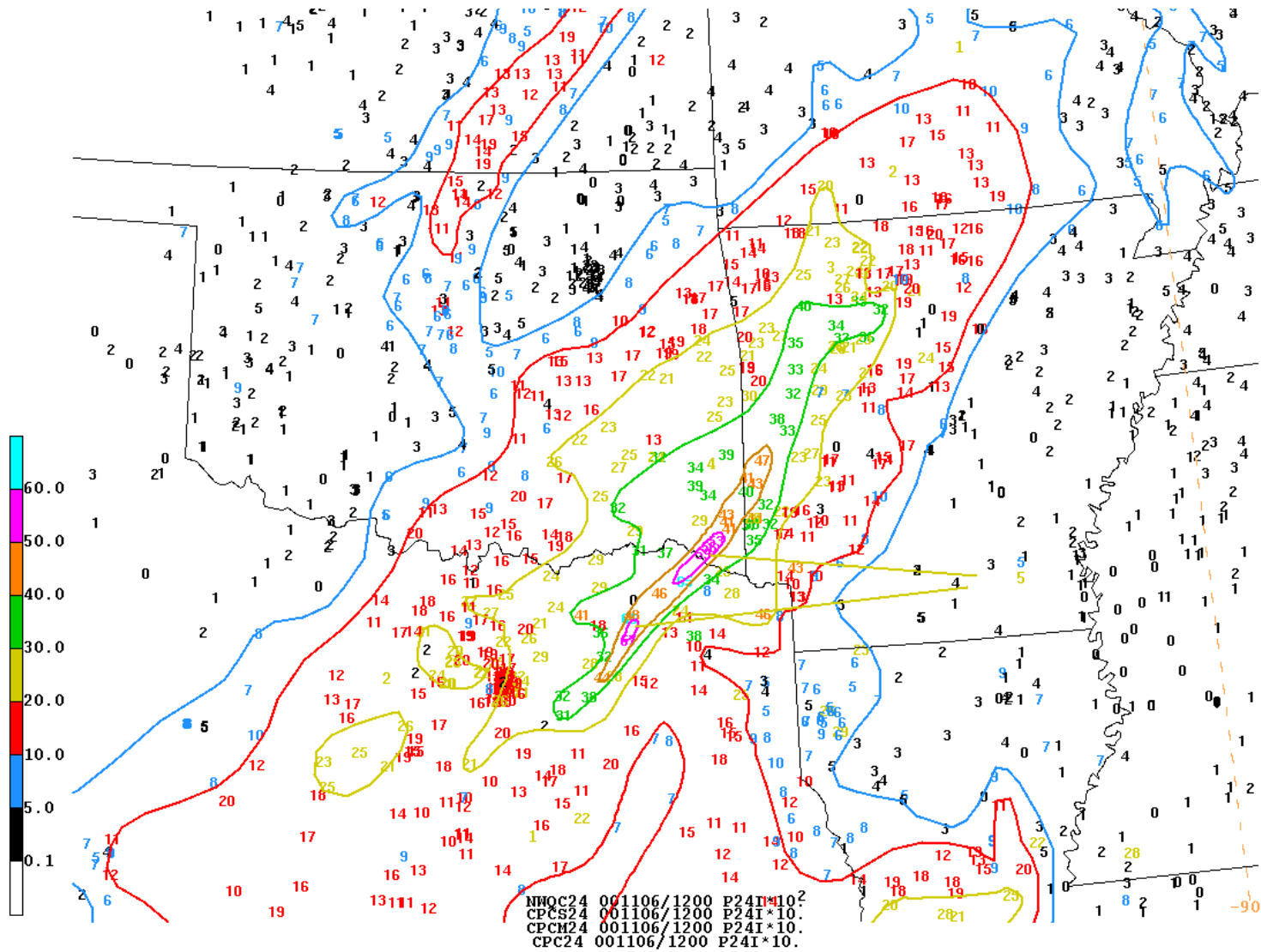
HPC QPF Verification (cont.)



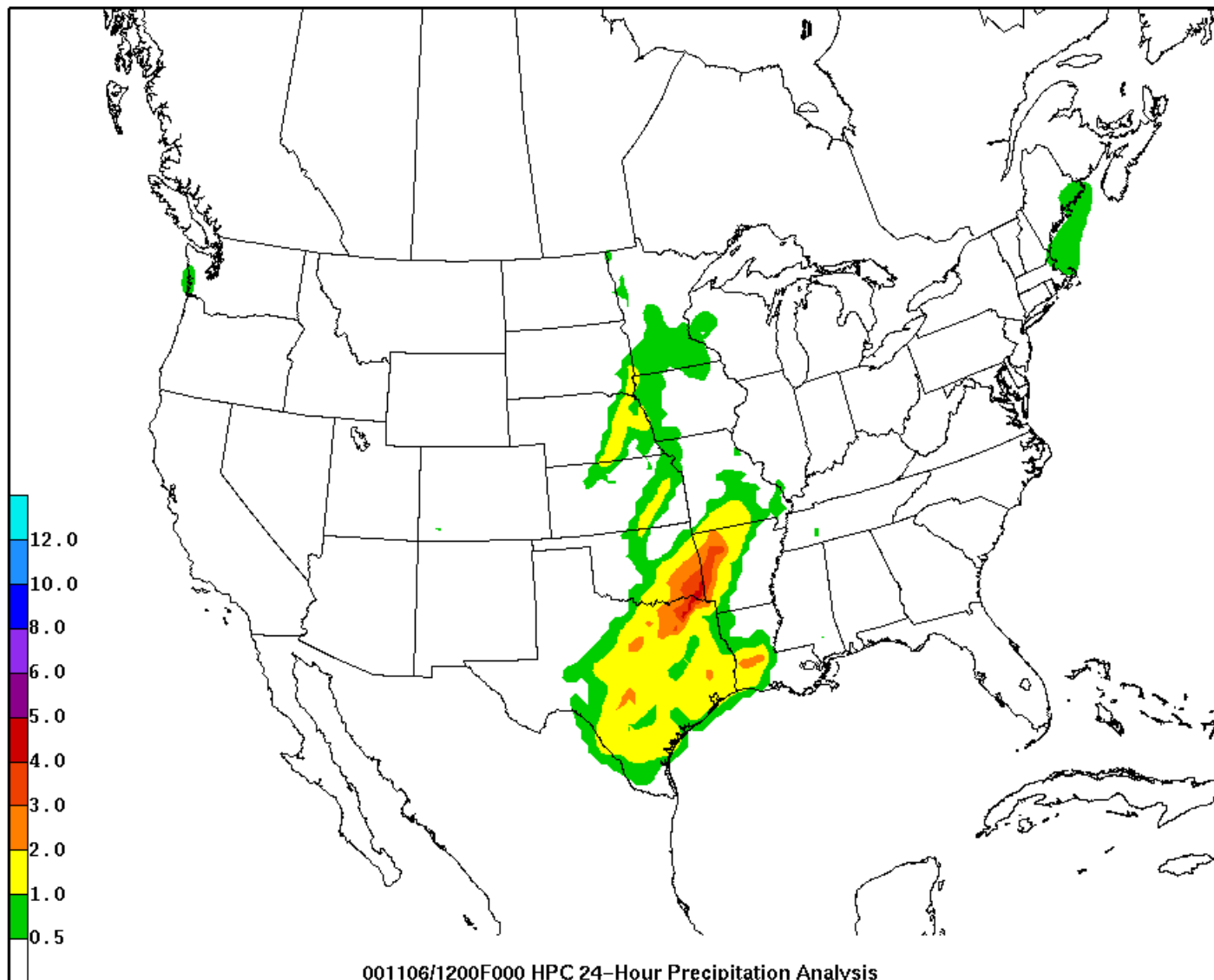
HPC QPF Verification (cont.)



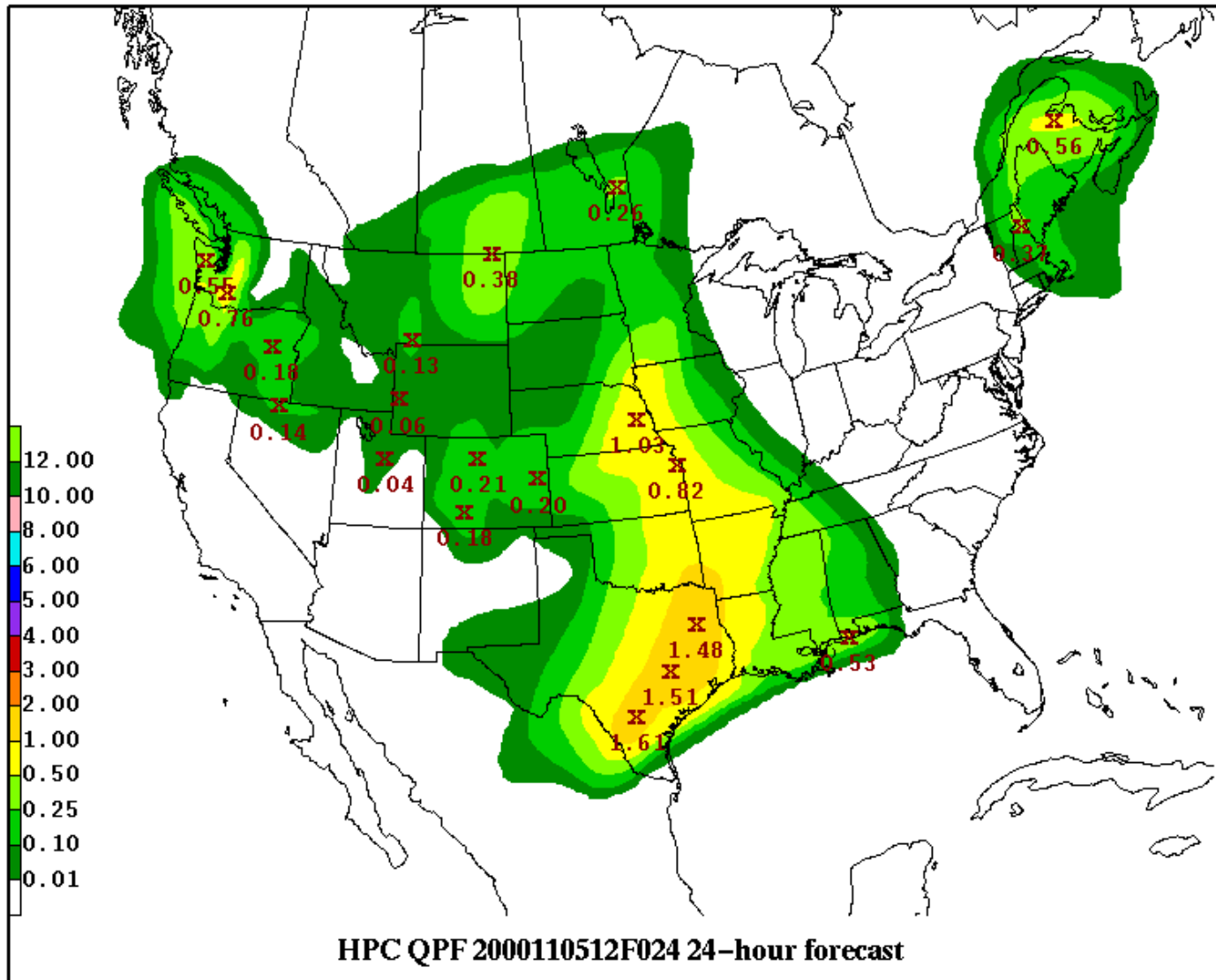
HPC QPF Verification (cont.)



HPC QPF Verification (cont.)

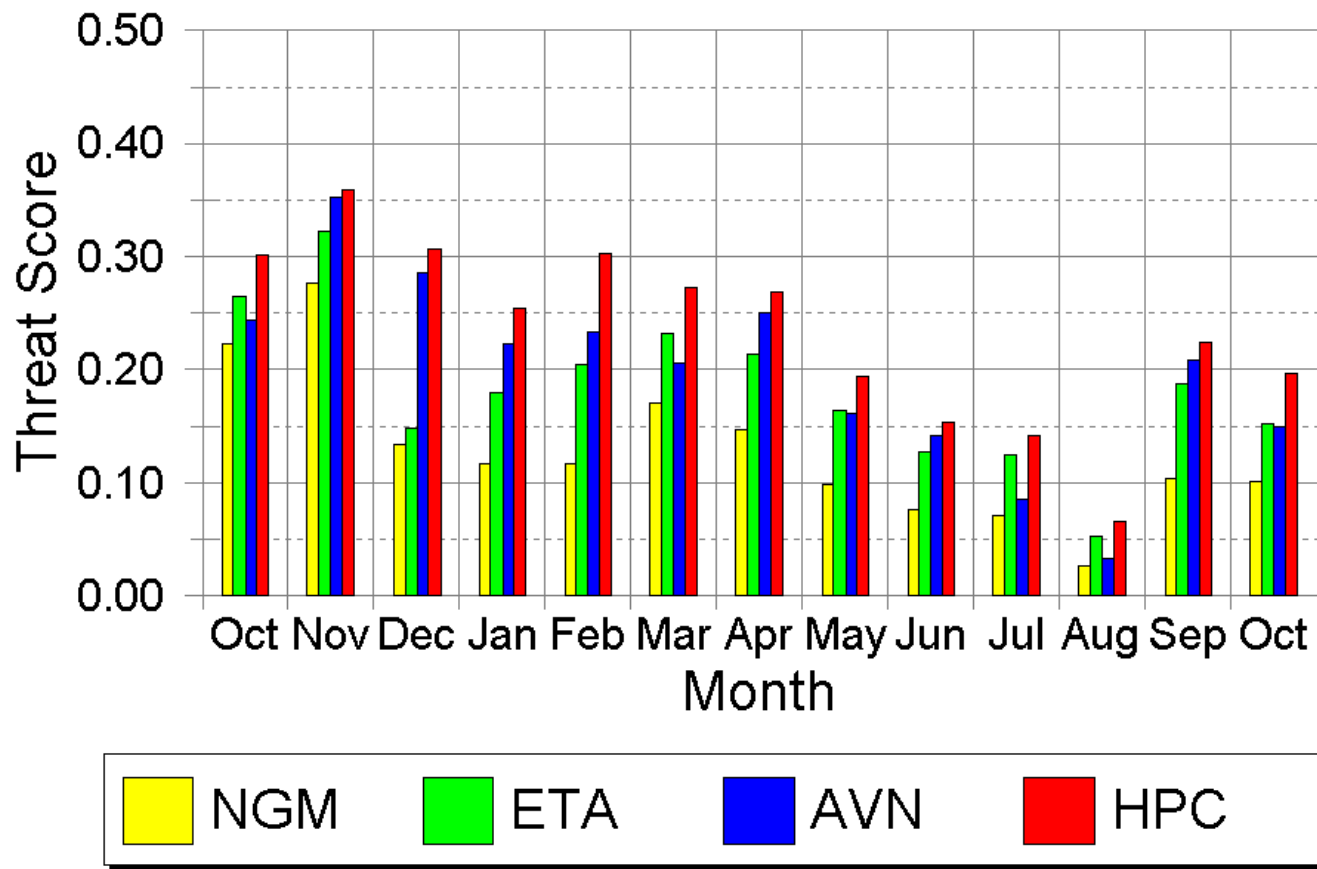


HPC QPF Verification (cont.)



HPC QPF Verification (cont.)

Threat Scores: 1-Inch QPF Day 1 Oct 1999 through Oct 2000



HPC QPF Verification (cont.)

120-hour QPF Verification

Gridded verification system

Lambert Conformal **32 km** Grid with normalization

CONUS land areas

Gauge-only analysis

120 hours of 24 hour point observations from CPC (Sid Katz)

Last 4 days QC'd by CPC (Wayne Higgins)

Simple Grid-Averaging to 32 km verification grid with “nudging”

Remap All Forecast Products to 32 km Verification Grid

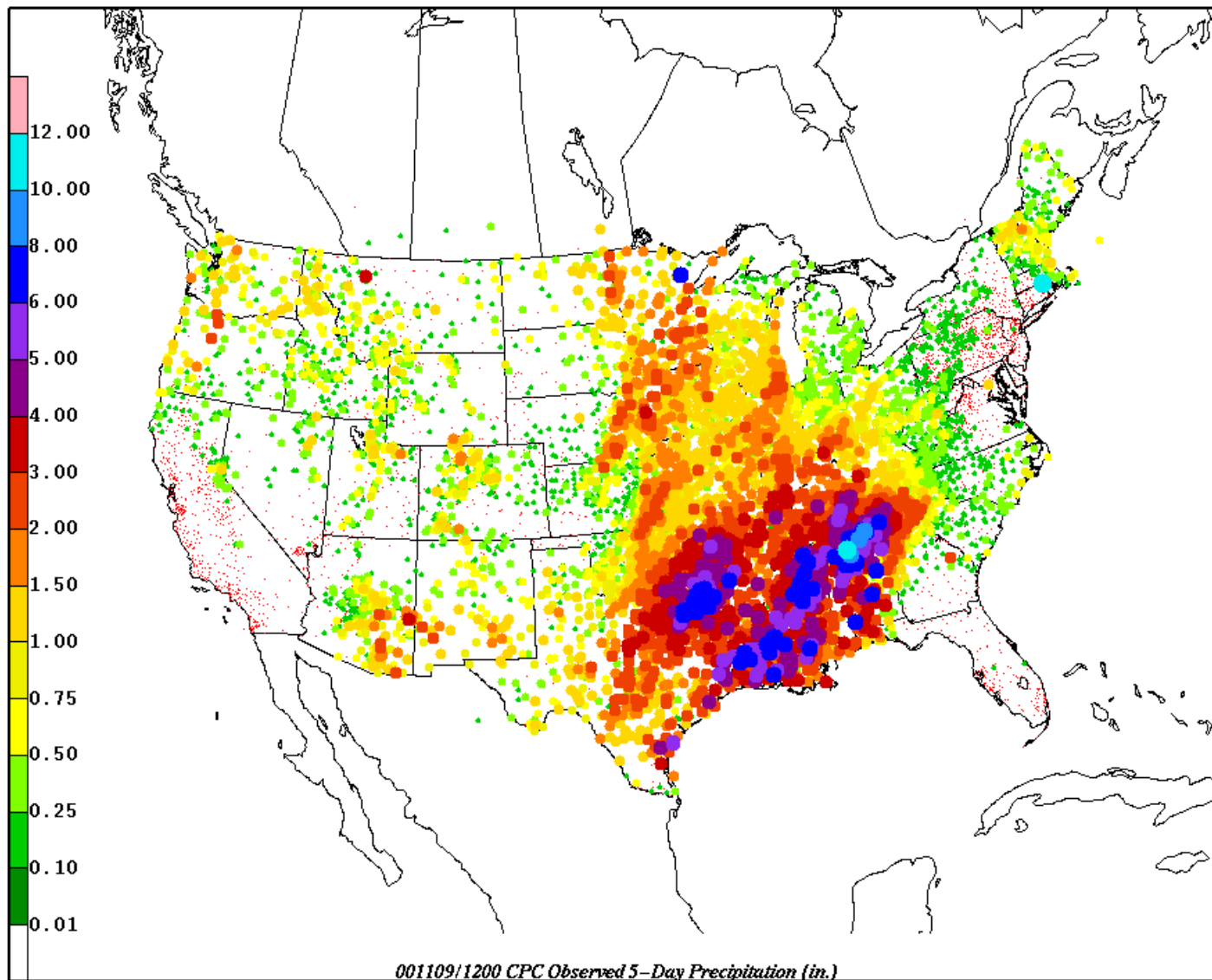
HPC, MRF, MFX & MRFY, ECMWF, NOGAPS

Area-Preservation Technique (EMC - Mesinger, Baldwin)

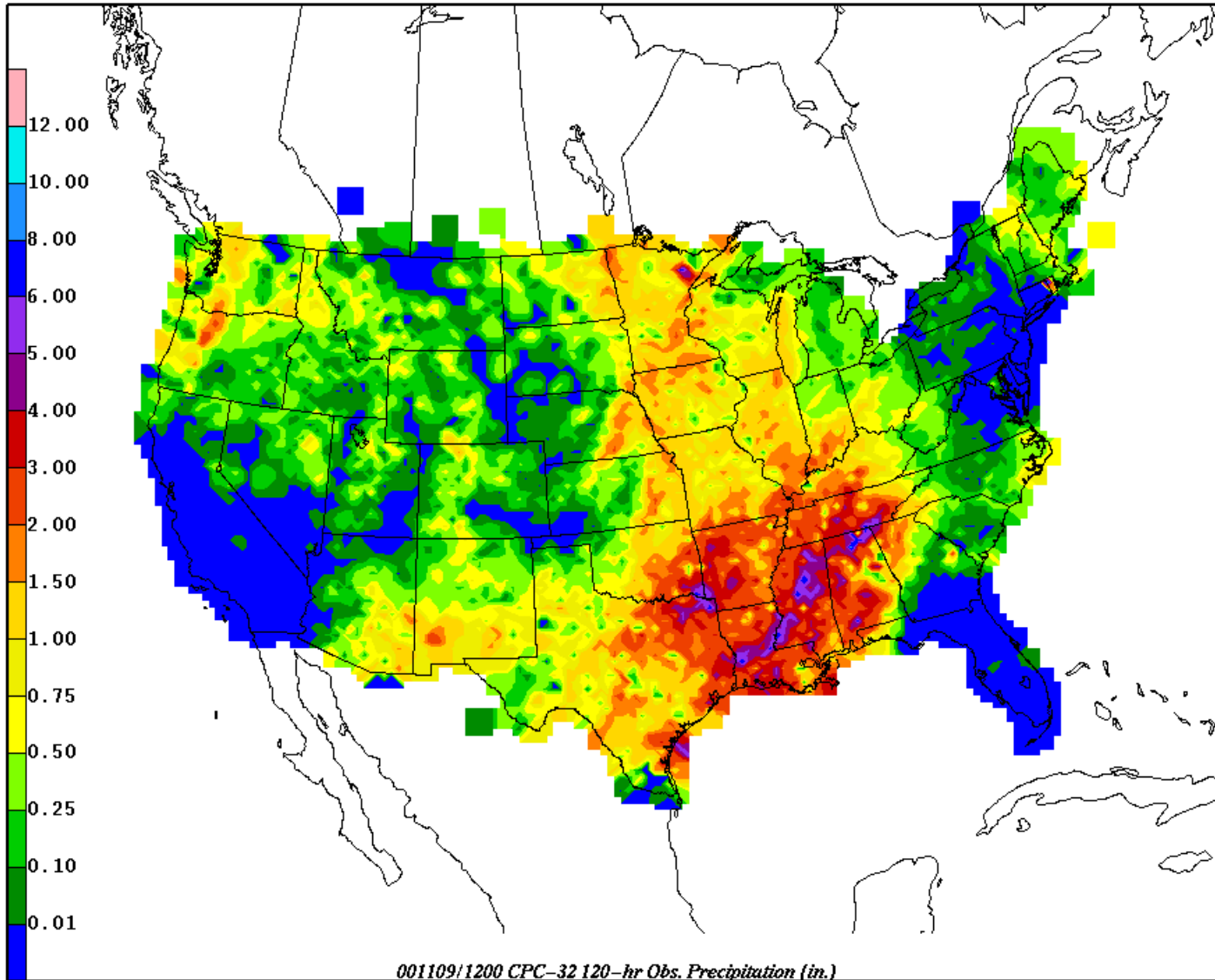
Compute Threshold Statistics beginning at 0.25”

Threat Score, Bias Score, POD, FAR, ETS

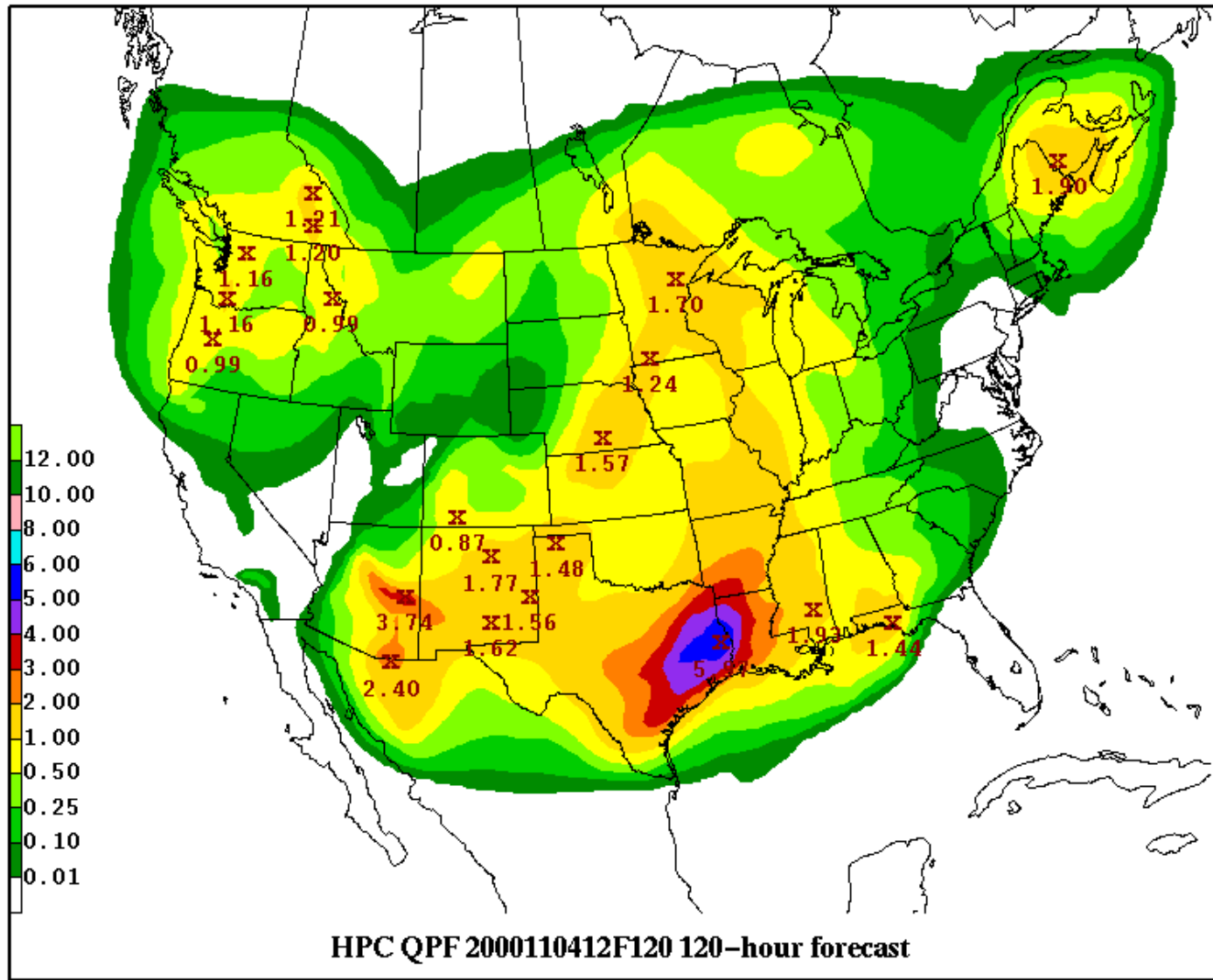
HPC QPF Verification (cont.)



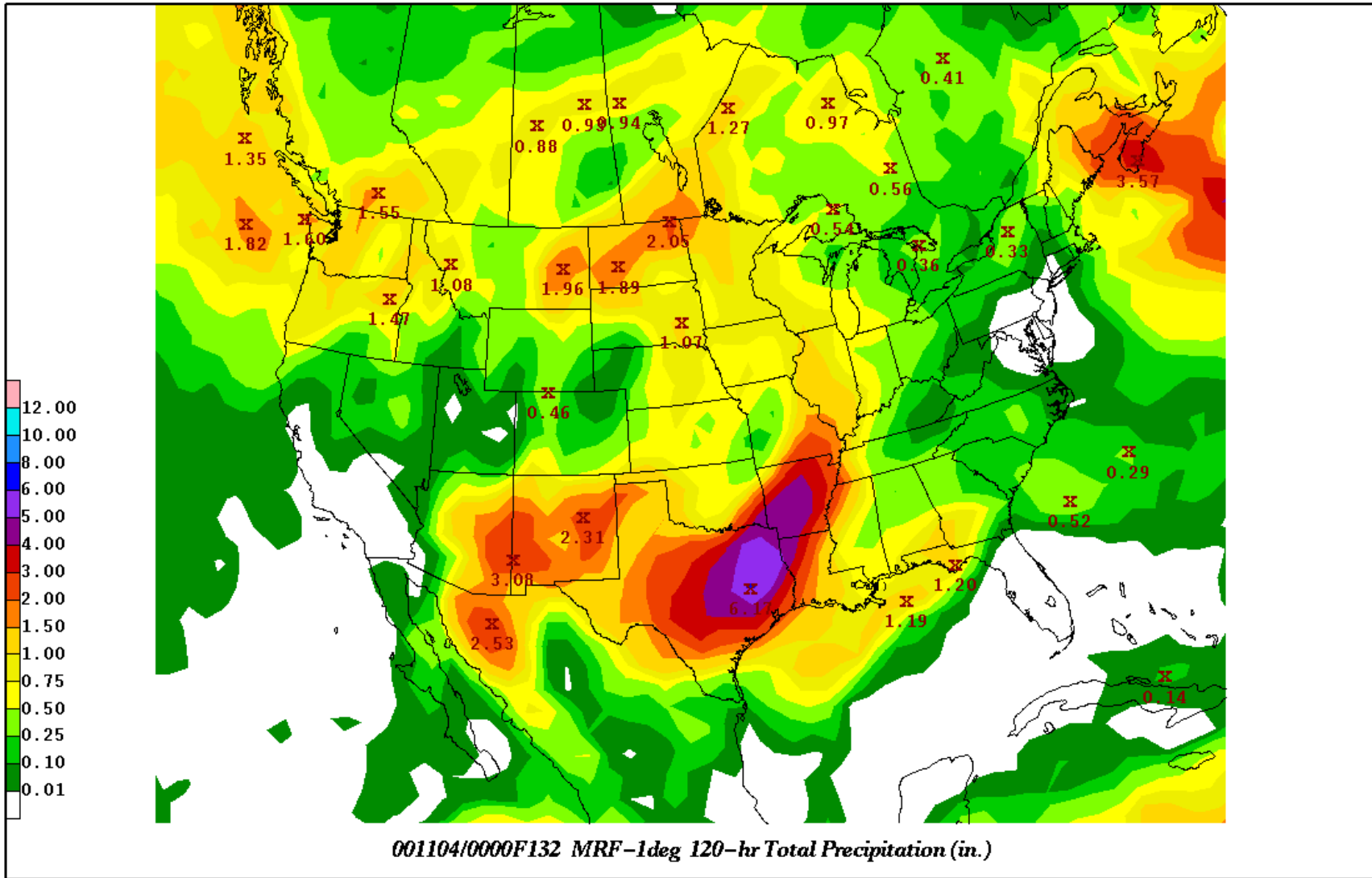
HPC QPF Verification (cont.)



HPC QPF Verification (cont.)

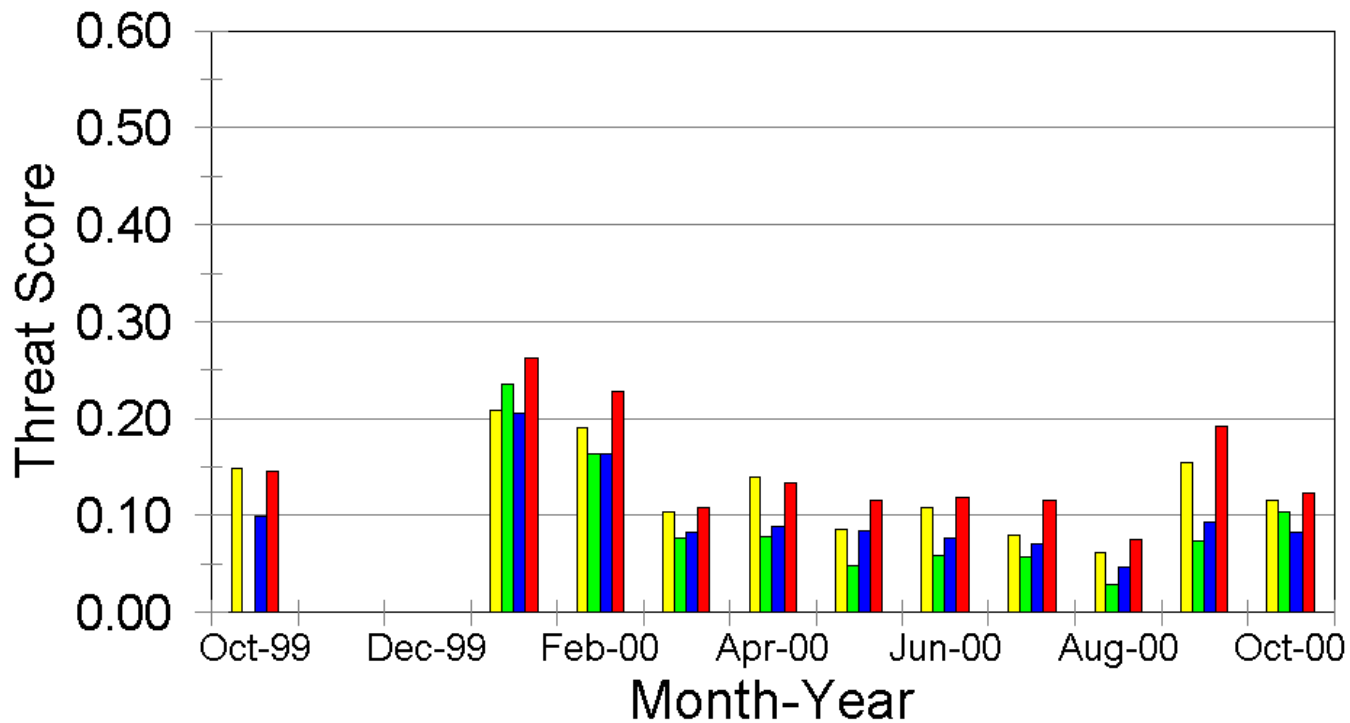


HPC QPF Verification (cont.)



HPC QPF Verification (cont.)

5-Day Total QPF Threat Scores: 2" Oct 1999 - Oct 2000



MRF

ECMWF

NOGAPS

HPC

Objective Verification (cont.)

- The National Precipitation Verification Unit (NPVU)

Established & administered by the NWS Office of Climate, Water, and Weather Services

Located at & co-managed by the NCEP Hydrometeorological Prediction Center

Purpose is to provide **timely & informative** QPF verification scores to HPC, RFC, & WFO forecasters, EMC & TDL modelers, and NWS management

NPVU

- **Uniform QPF Verification Program**

 - Prototype development for the QPF Process Assessment & Western Region Follow-on Assessment

 - Central location where verification statistics are computed in the same manner everywhere

 - Raw Data decoded into GEMPAK file formats - both types are archived

- **Data Ingest & Archival - Observations**

 - Point Observations:

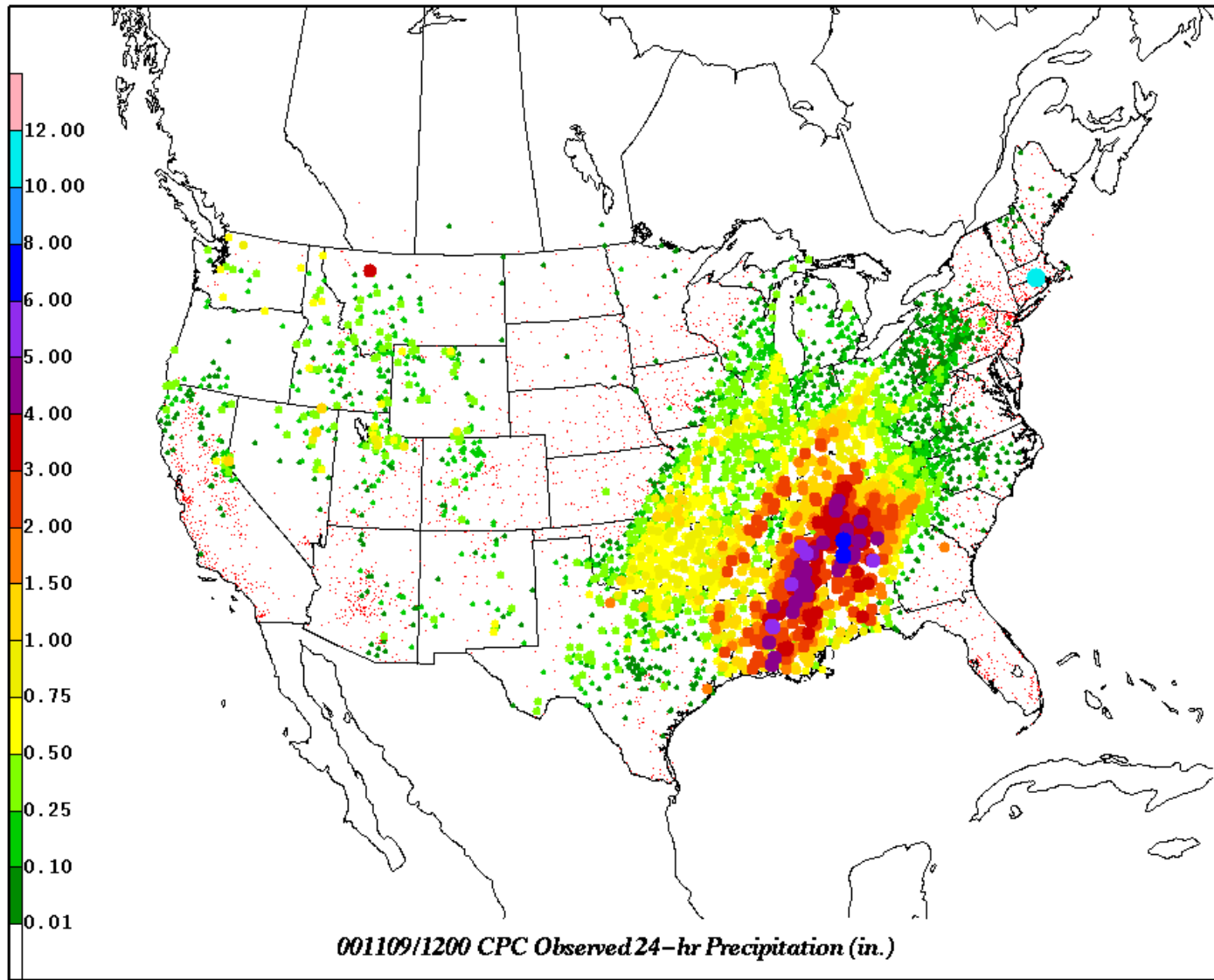
 - RFC HYD Bulletins

 - 06- and/or 24-hour amounts

 - Quality Controlled

 - SHEF -> GEMPAK surface files

NPVU (cont.)



NPVU (cont.)

Gridded Quantitative Precipitation Estimates (QPEs):

From the River Forecast Centers

Multi-Sensor Data from Stage III, RFC-Wide, P1, or Mountain Mapper

Quality Controlled

HRAP grid (4 km) resolution of 06-hr amounts

Mosaic RFC QPEs together (using bitmaps of RFC domains) for CONUS - sent out on AWIPS in Build 5.1?

Remap 4 km grids to 32 km verification grid using Grid-Averaging Technique

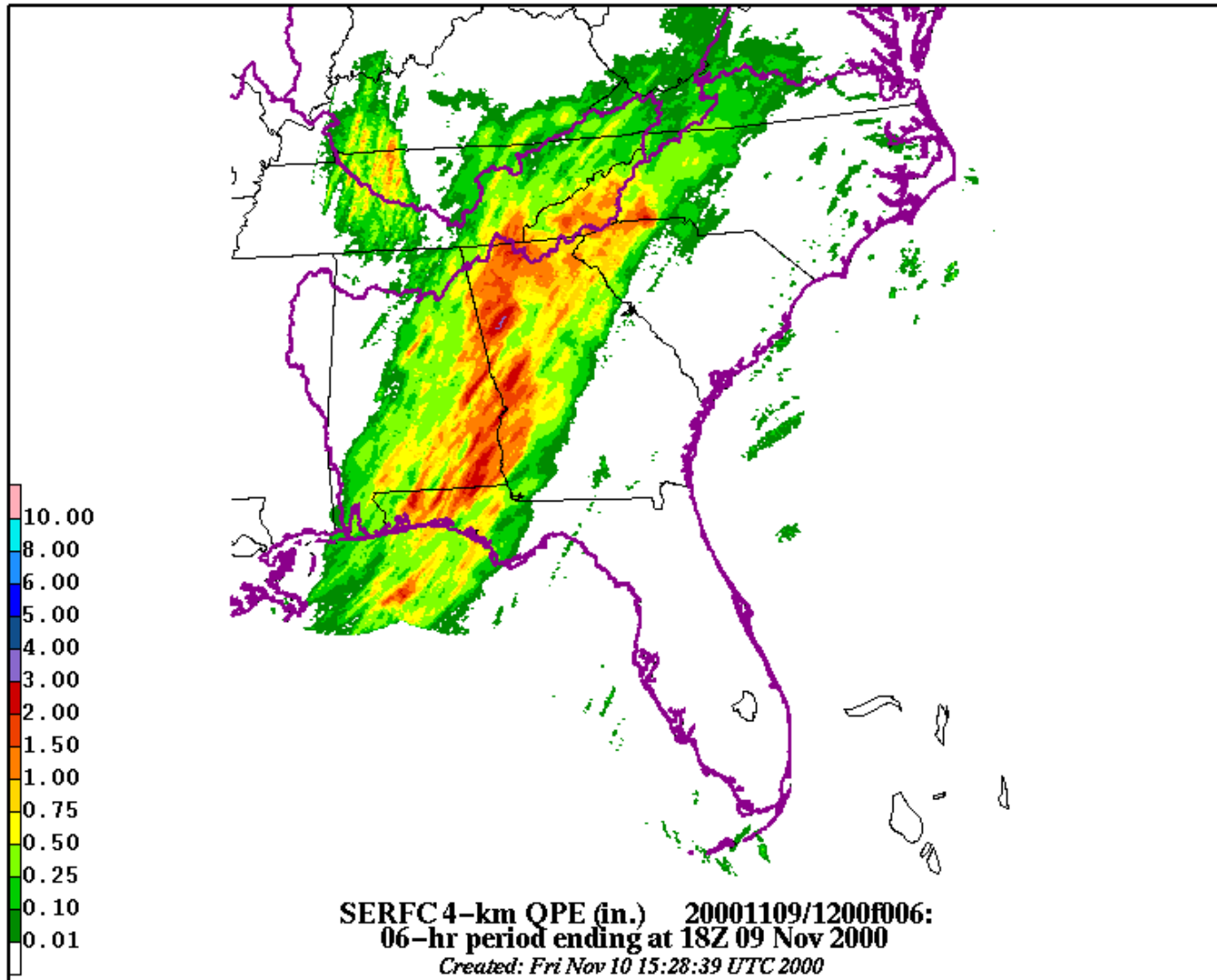
GRIB -> GEMPAK gridded files

Mean Area Precipitation (MAP) Amounts:

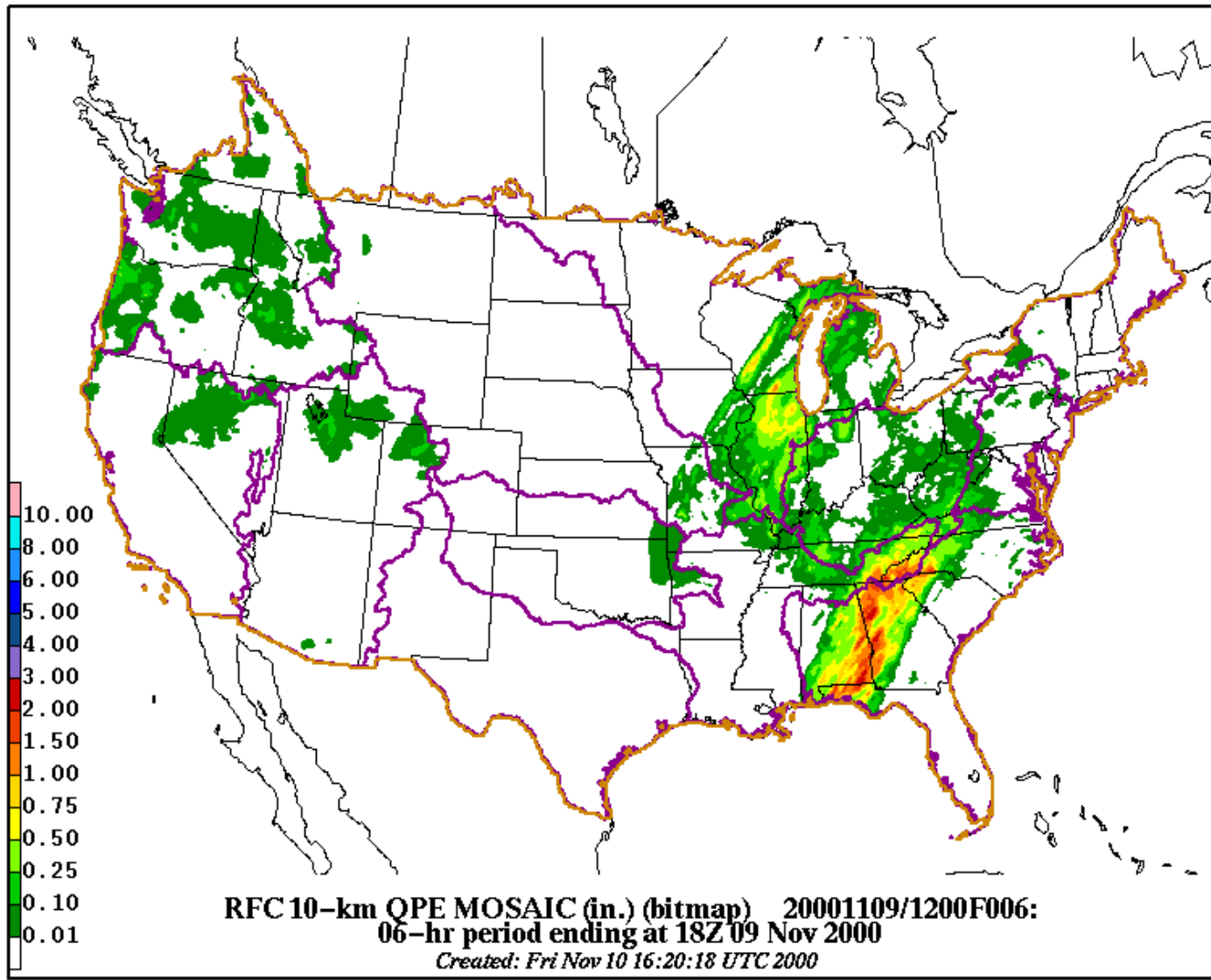
From the River Forecast Centers (NPVU does/will not generate MAPs because process differs at each RFC)

SHEF? -> GEMPAK surface files

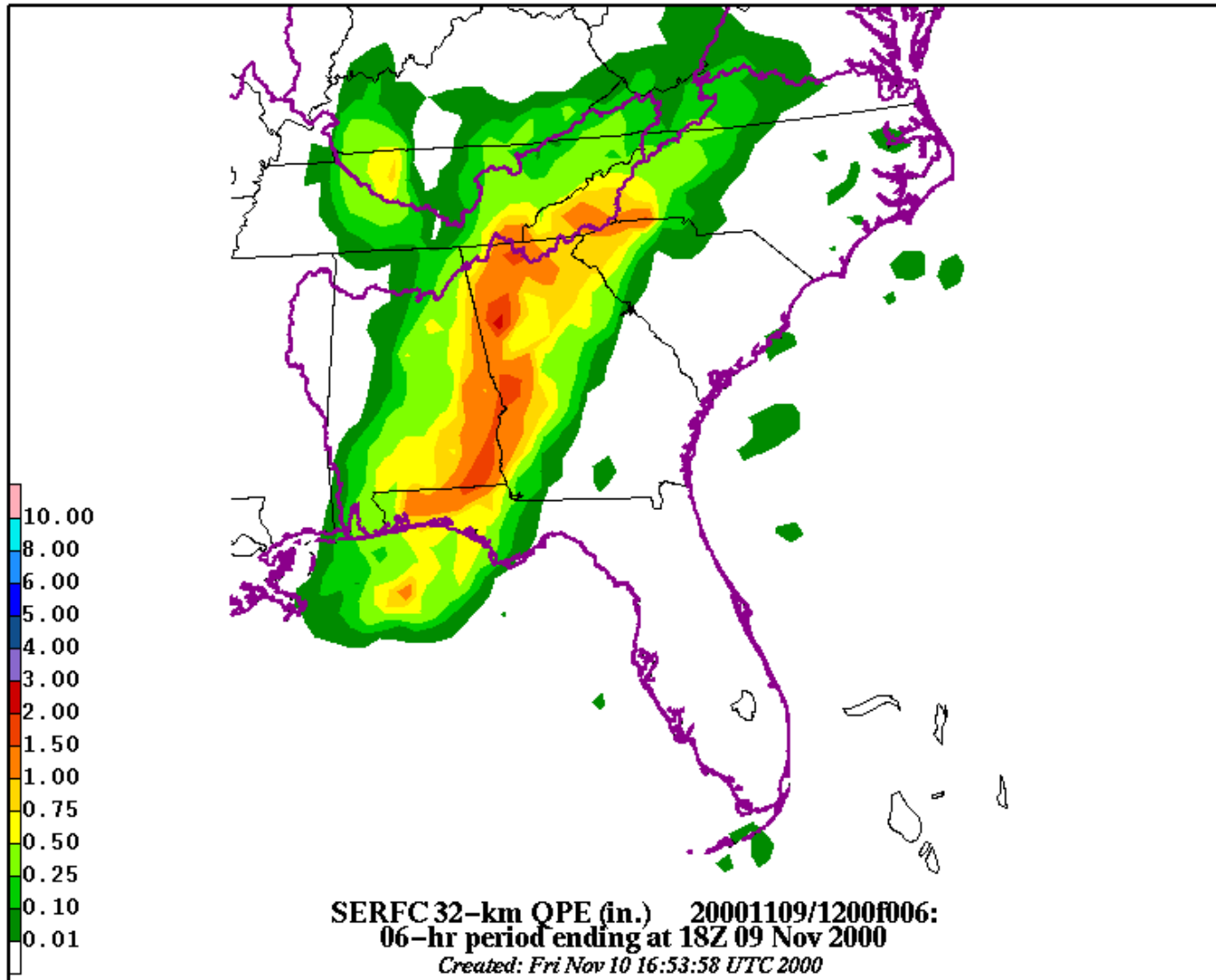
NPVU (cont.)



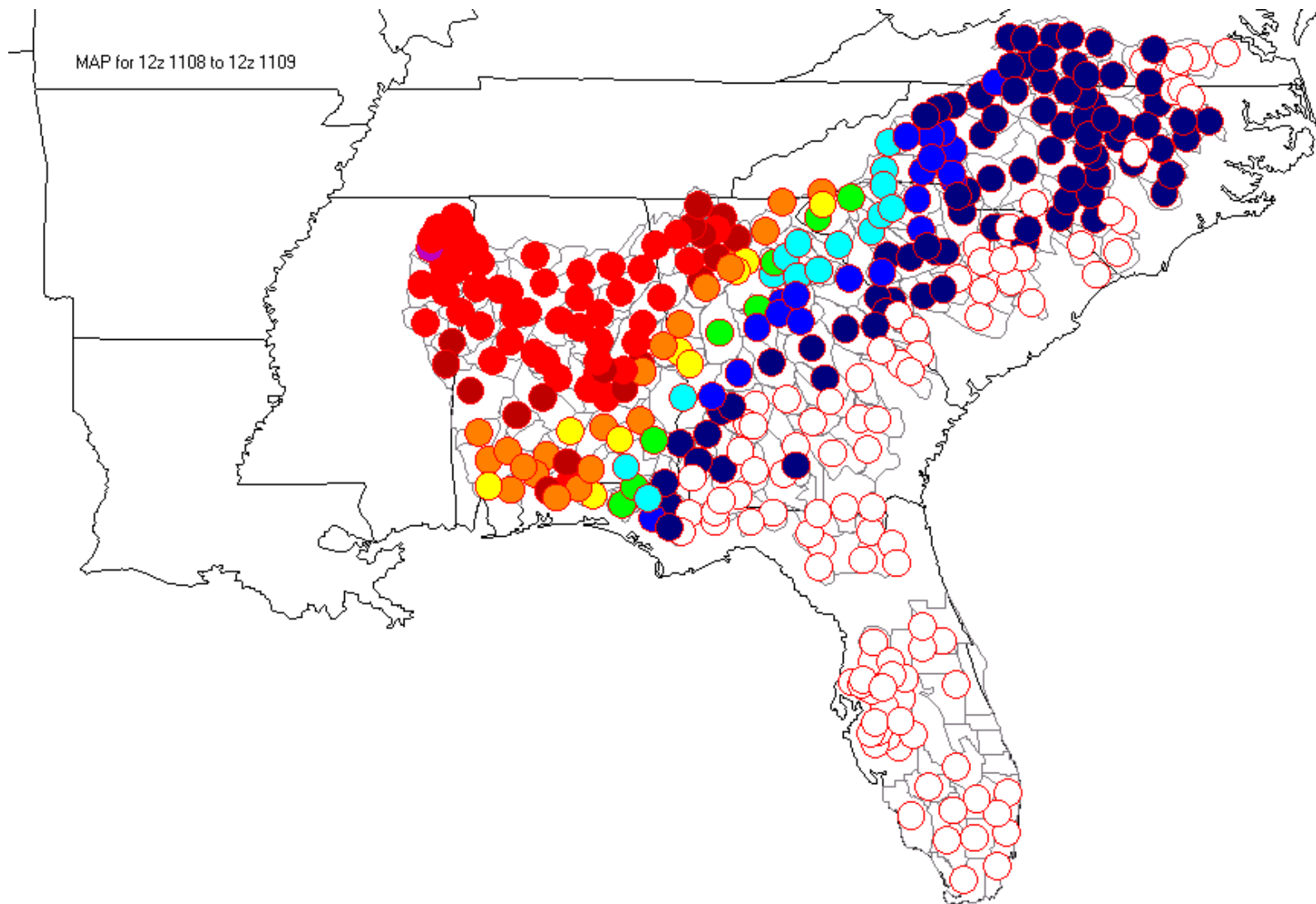
NPVU (cont.)



NPVU (cont.)



NPVU (cont.)



NPVU (cont.)

• Data Ingest & Archival - Forecasts

NWP Model QPFs -

NGM, Eta, AVN

Retrieve GRIB files directly from IBM SP on highest resolution grids possible

HPC QPFs -

Now - Receive .vgf & .info files directly ->

Run "Graph-to-Grid" ->

32 km Grid

Future - Receive and decode GRIB files

Create point QPFs in WR using bilinear interpolation

NPVU (cont.)

RFC QPFs -

Creating using NMAP or Mountain Mapper

10-km QPF GRIB files sent to IBM SP via AWIPS

Mosaic RFC QPFs together (using bitmaps of RFC domains) for CONUS ->
sent out on AWIPS

Remap to 32 km verification grid using APT

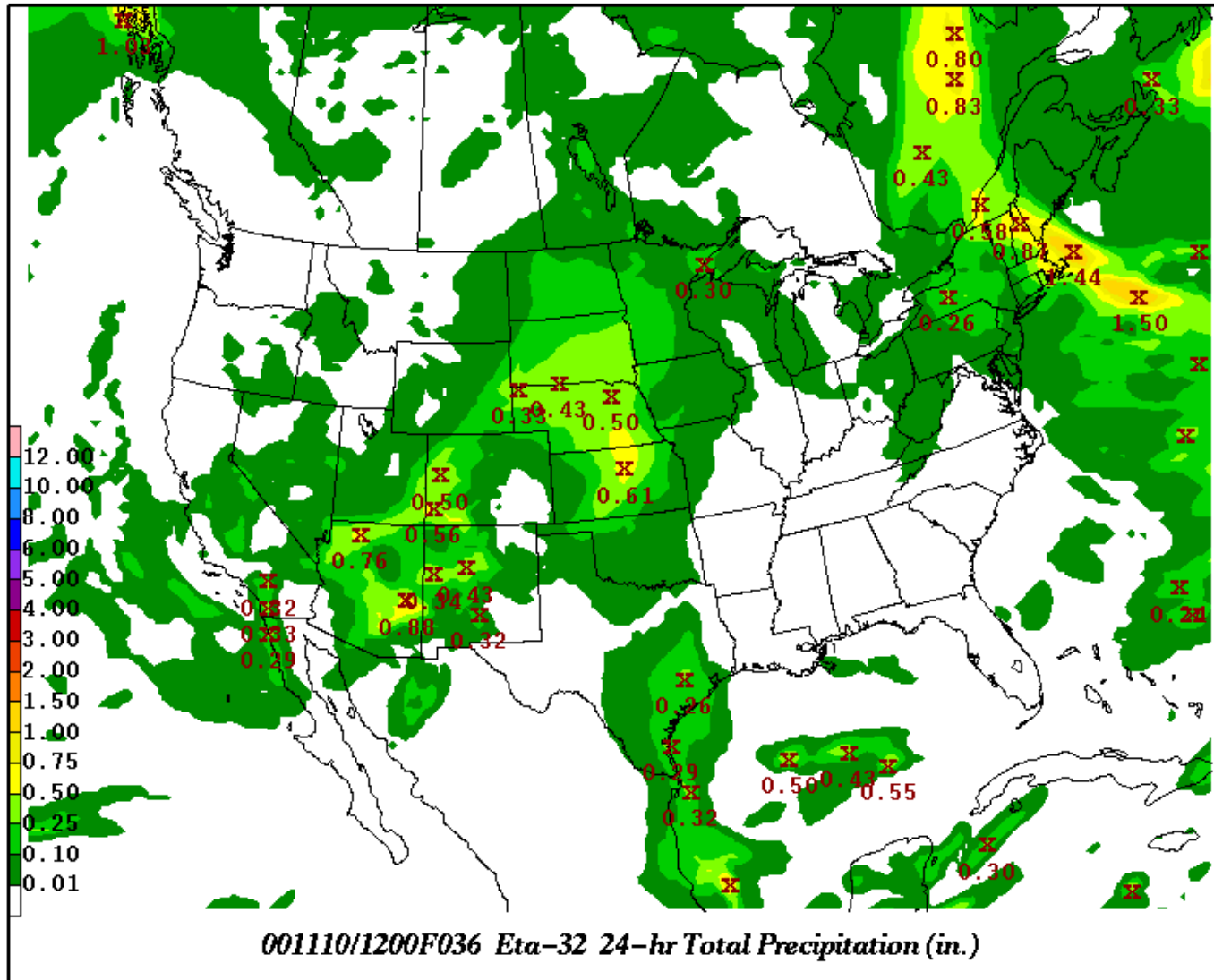
WR QPF points via SHEF files (QPS)

WFO QPFs - ?

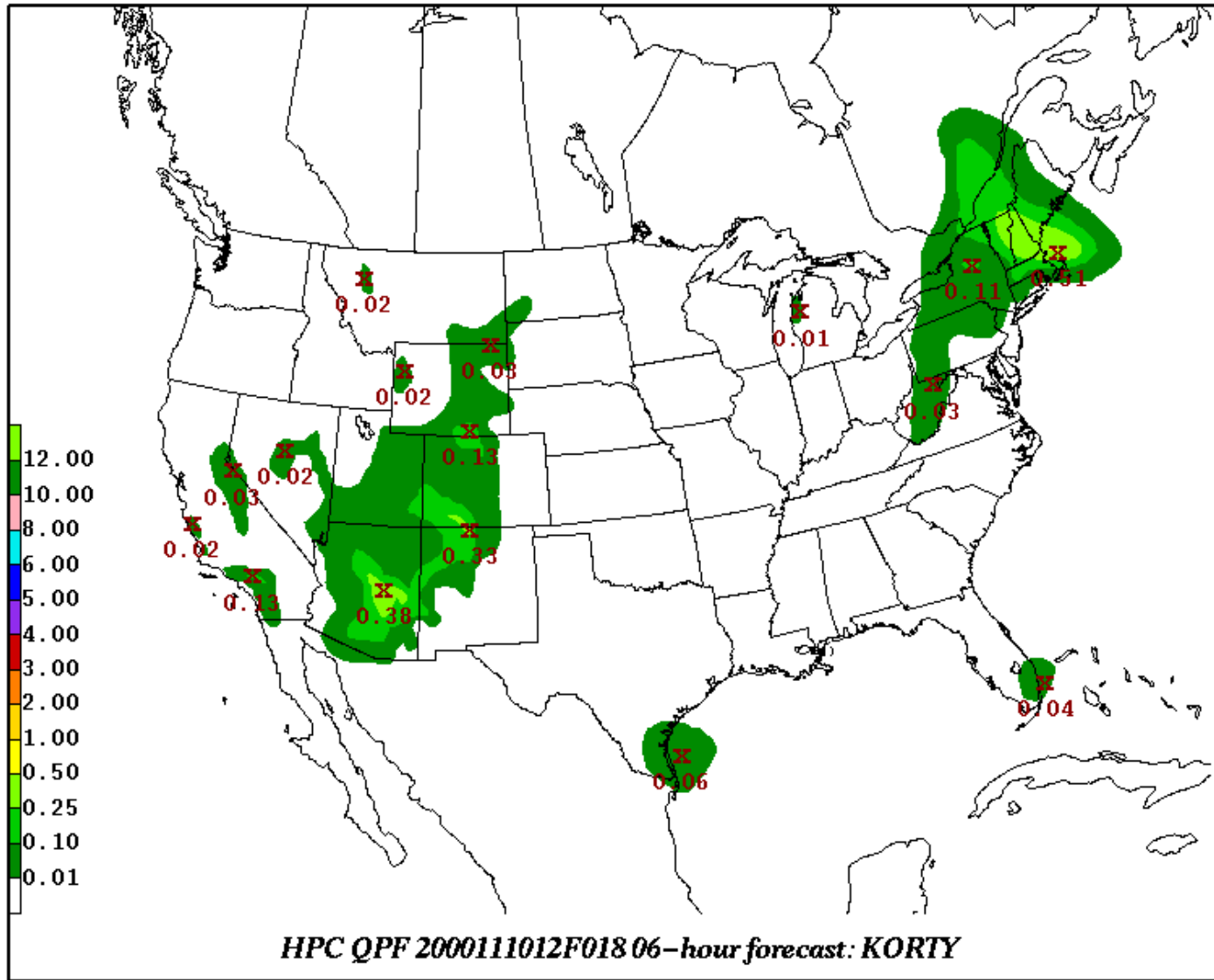
• Climatology

PRISM

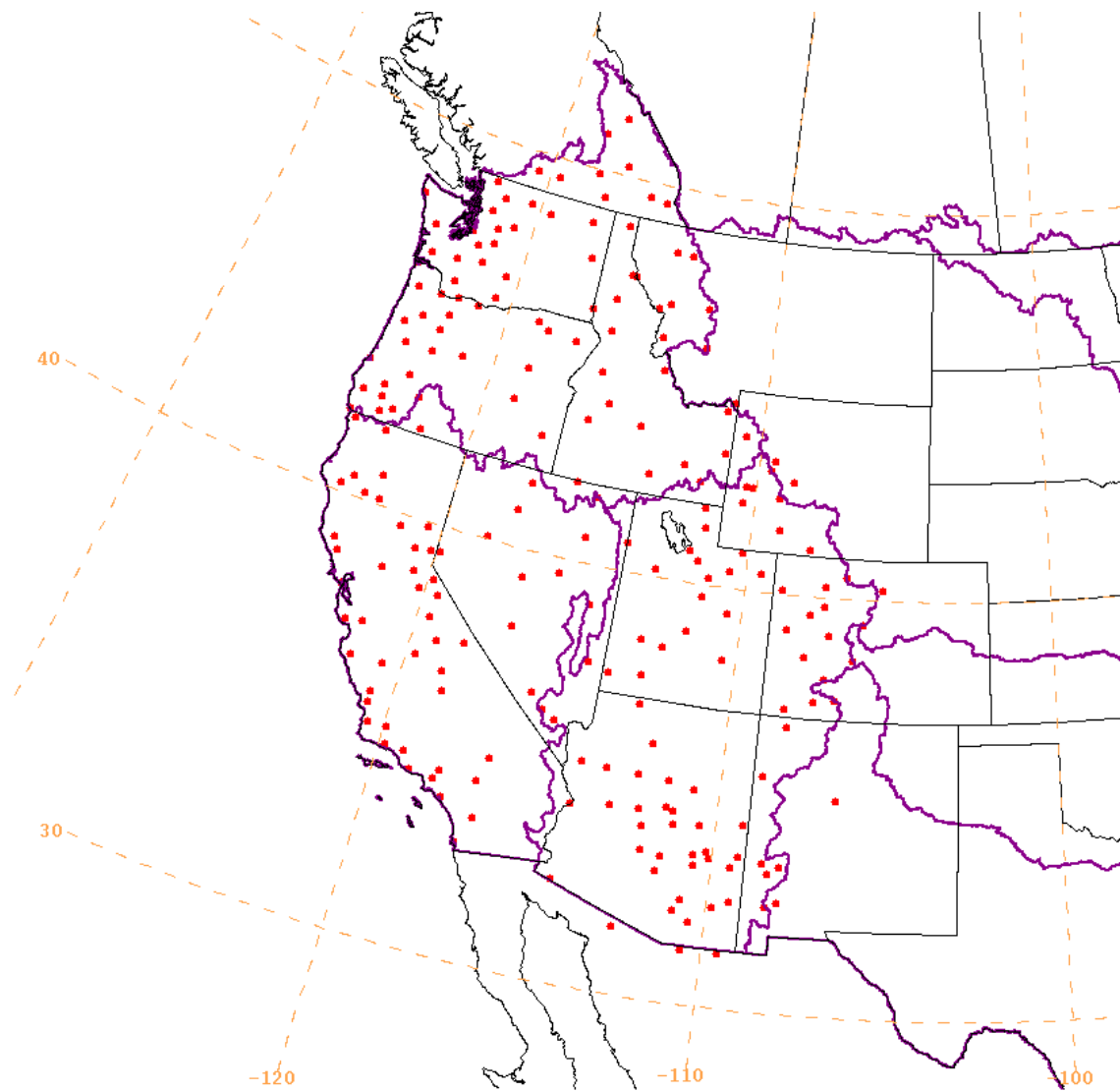
NPVU (cont.)



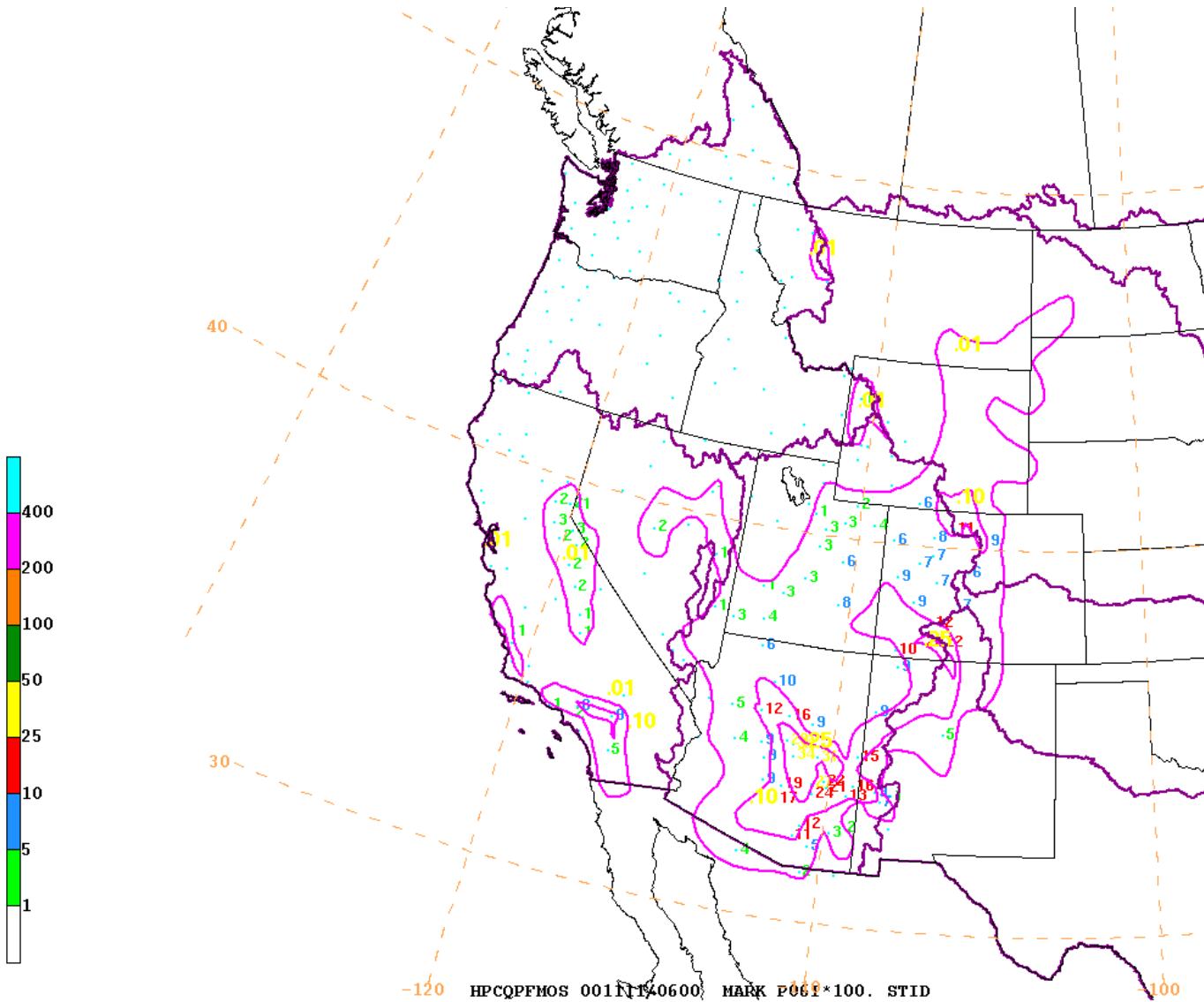
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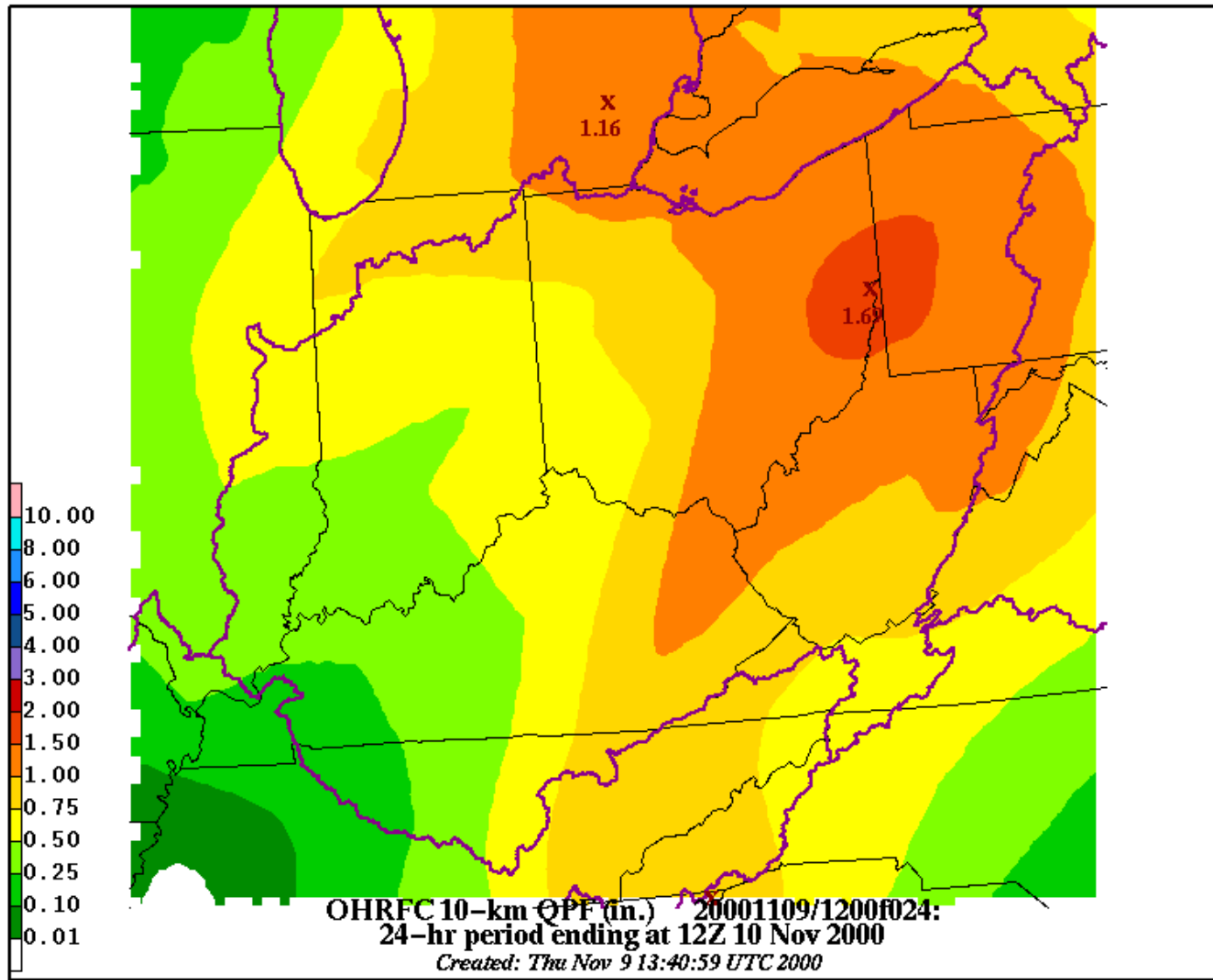
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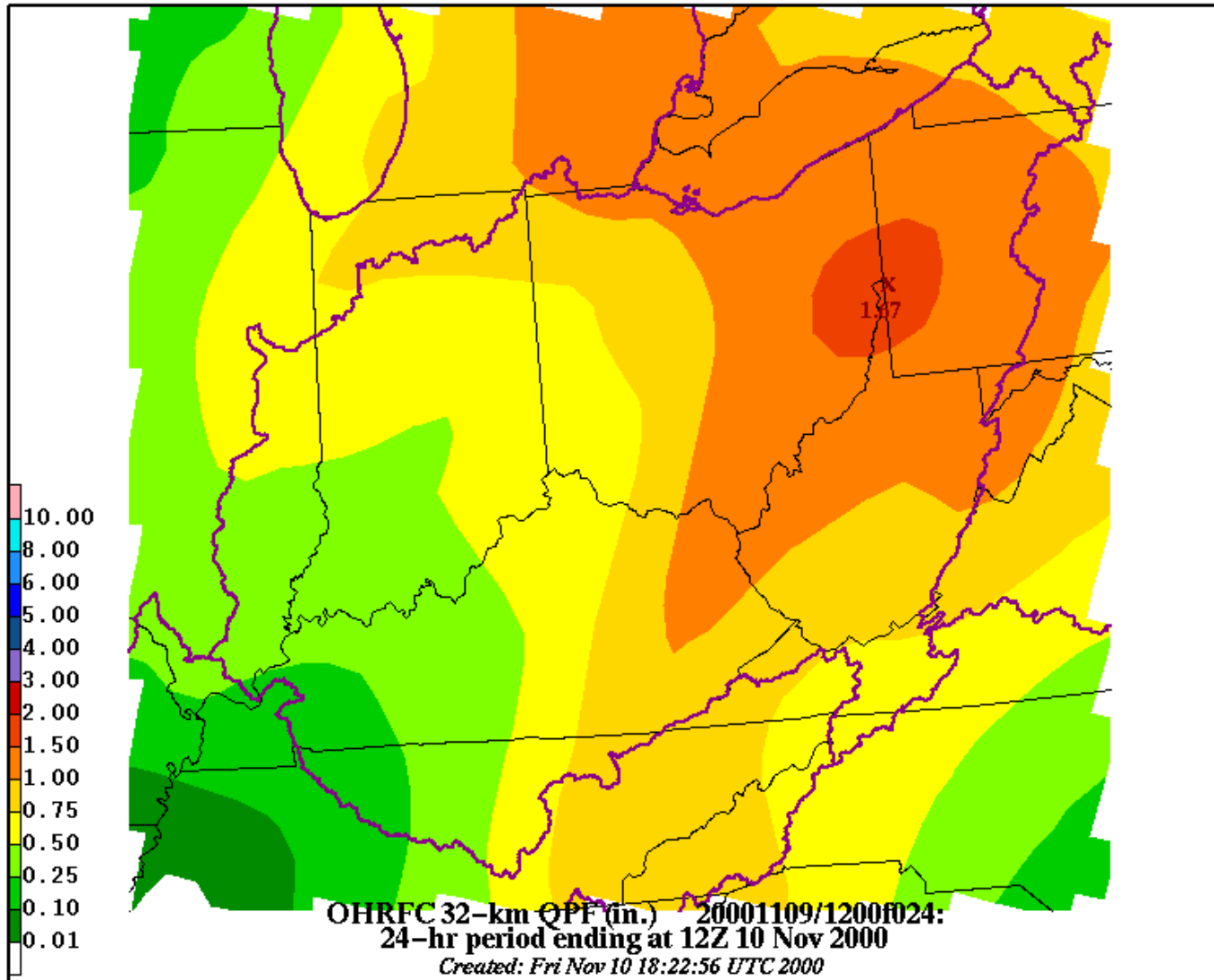
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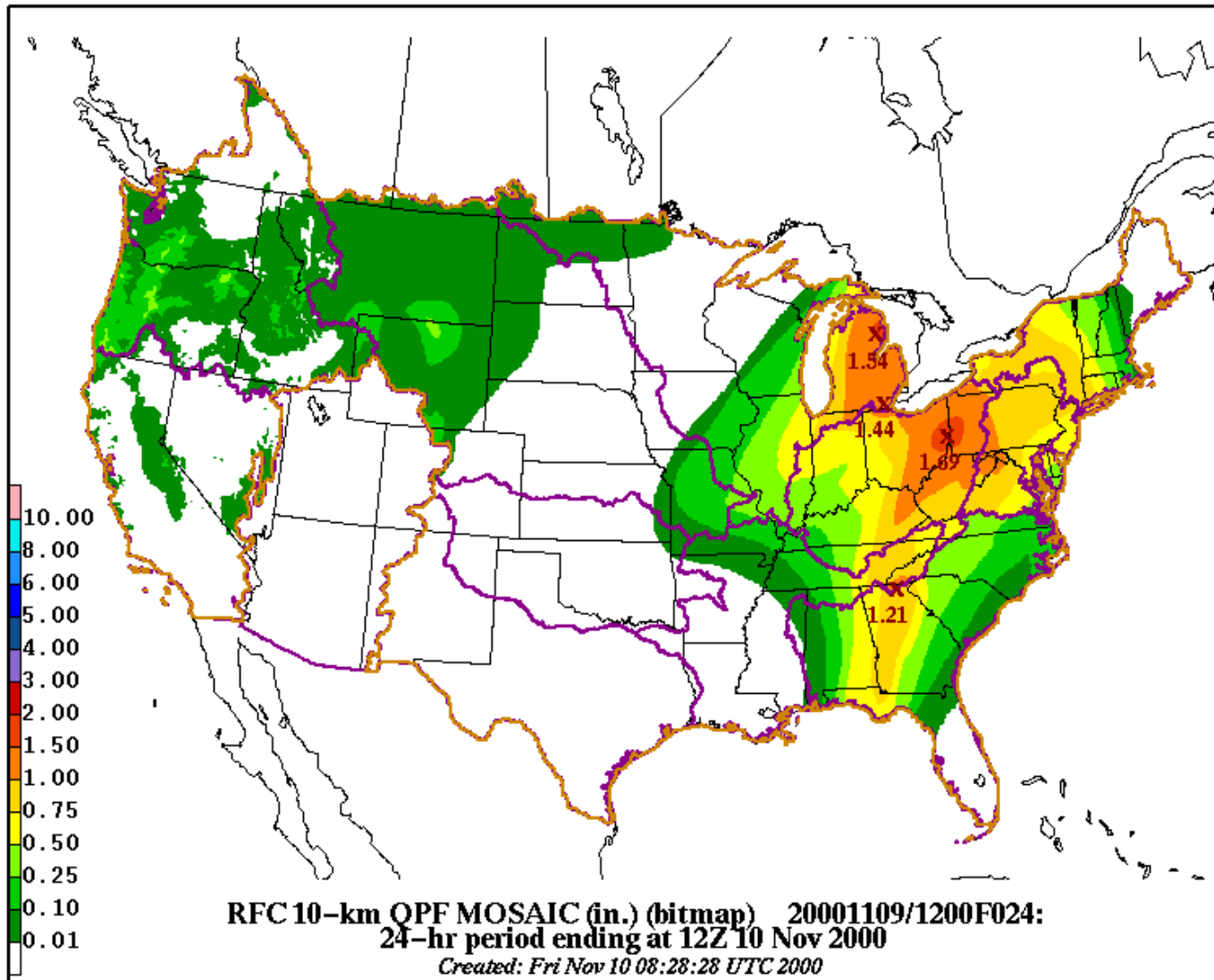
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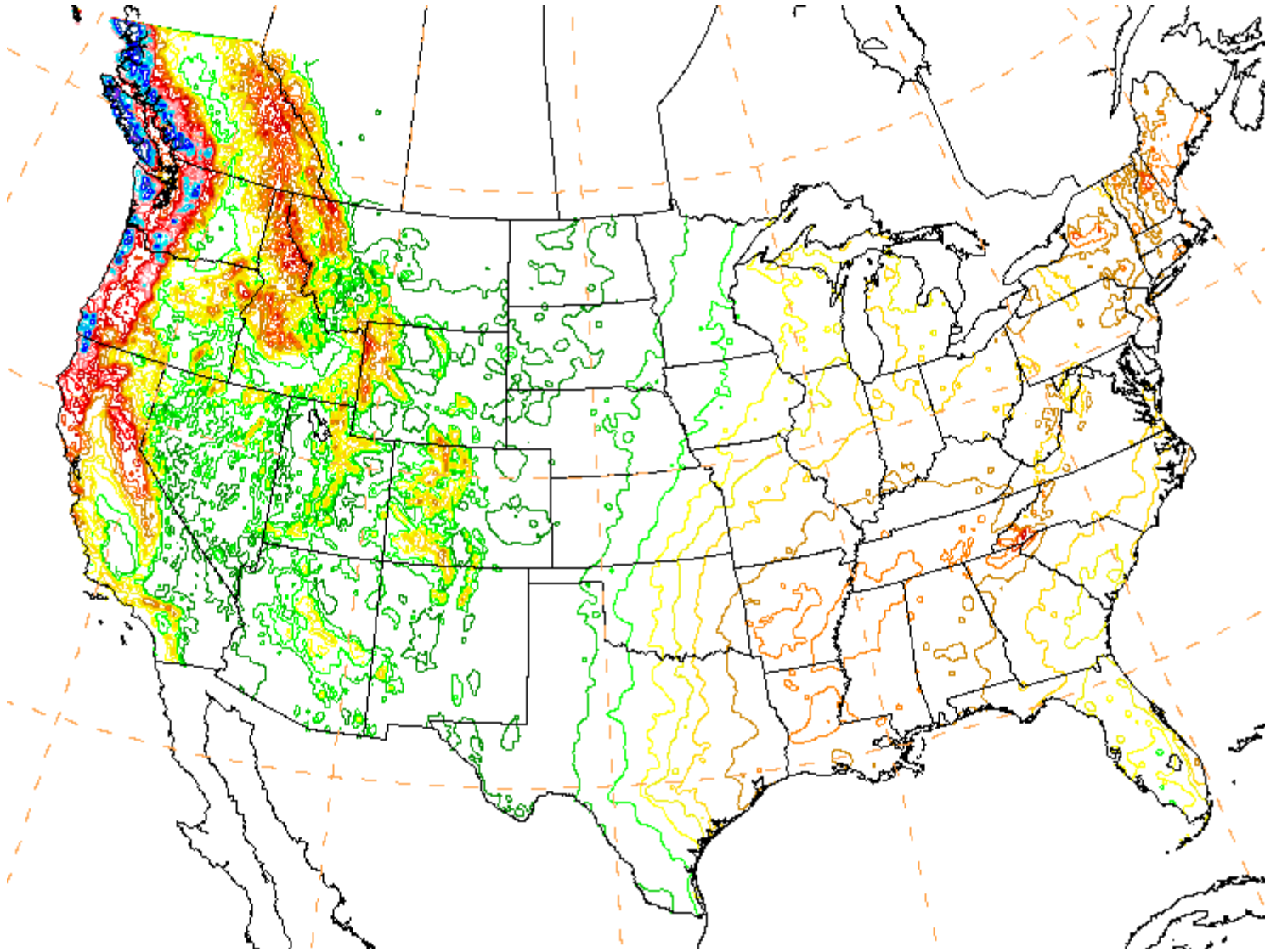
NPVU (cont.)



NPVU (cont.)



NPVU (cont.)



NPVU (cont.)

Verification statistics computed from QPFs for possible combinations of the following *as appropriate*:

Primary Methodology - gridded, with a spatial resolution of ~32 km (Points and MAPs supplemental)

Forecast Increments: 6- & 24-hr, etc.

Forecast Projections: 1st period, Day1, etc.

Spatial Domains: nation, region, RFC domain, etc.

Temporal Domains: forecast period, forecast cycle, event, week, month, season, year, etc.

NPVU (cont.)

- Performance Measures:

Error Statistics -

Mean Error

Mean Absolute Error

Root-Mean-Squared Error

Threshold Statistics -

Threat Score

Bias Score

Probability of Detection

False Alarm Rate

Equitable Threat Score

NPVU (cont.)

Interval & Threshold Distributions

Other Possible Performance Measures:

Bayesian Informativeness Score

Correlation Coefficient

Nash-Sutcliffe Sufficiency Score

Brier Score

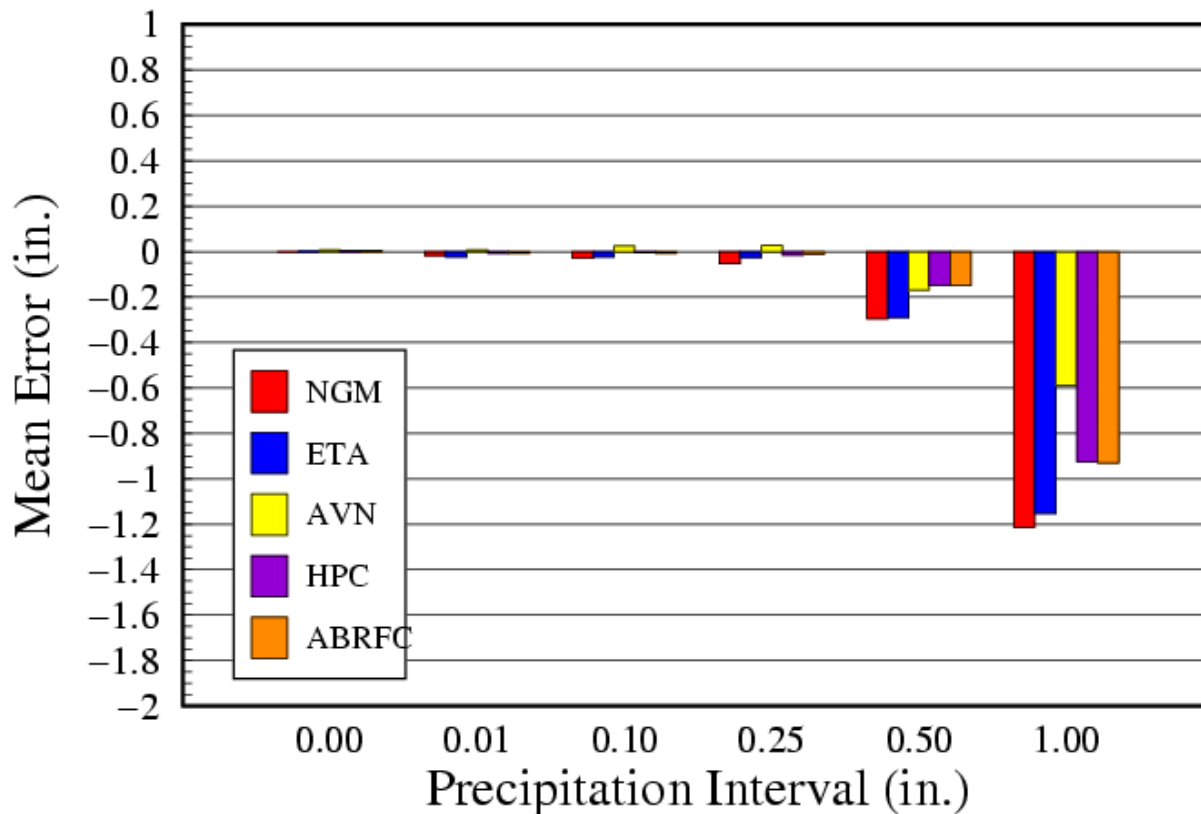
Ranked Probability Score

Etc.

NPVU (cont.)

NPVU – ABRFC – ME

Oct2000 DAY1 06H GRD (OBS & FOR)

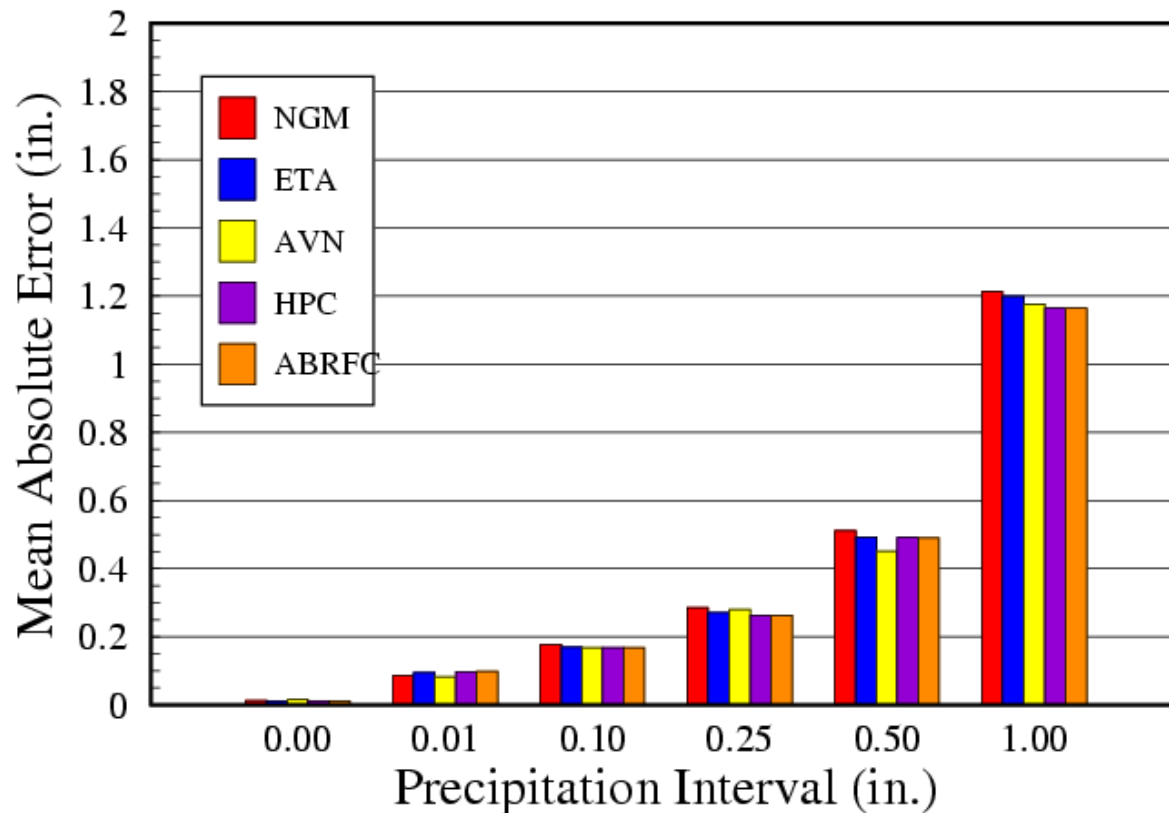


Thu Nov 2 10:12:09 2000

NPVU (cont.)

NPVU – ABRFC – MAE

Oct2000 DAY1 06H GRD (OBS & FOR)

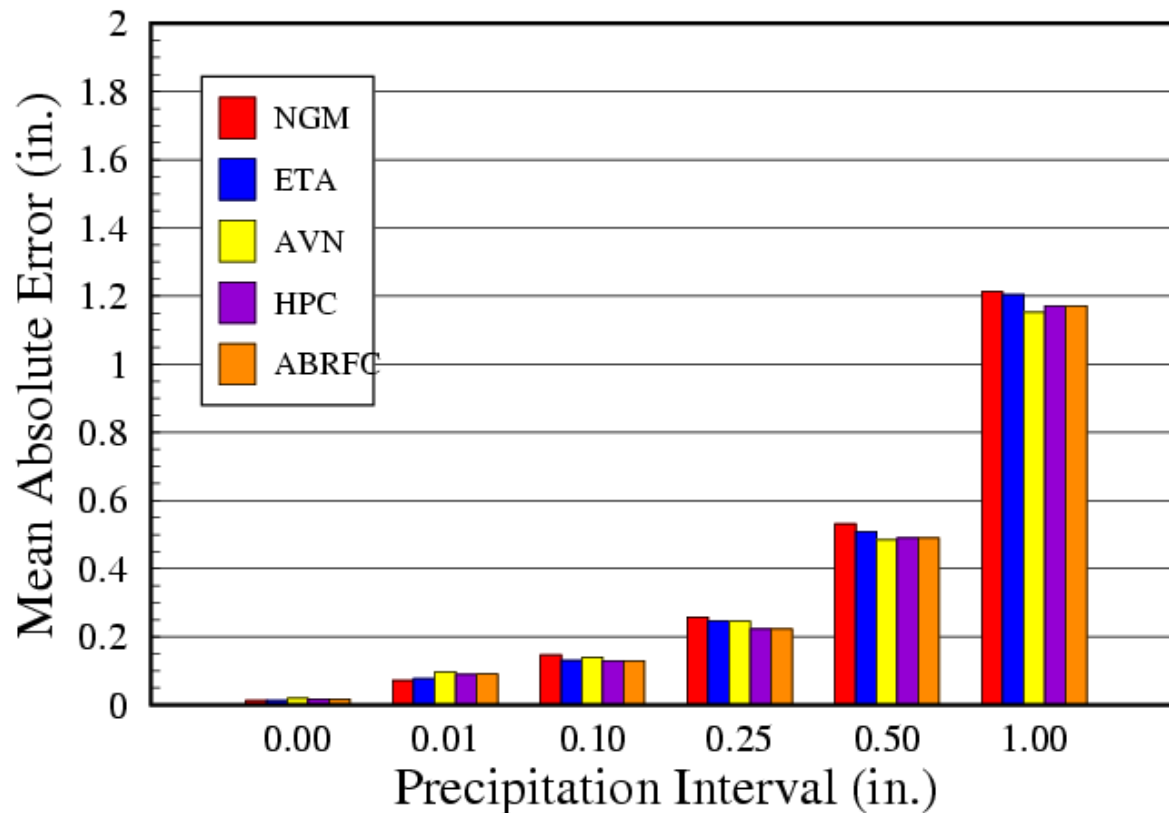


Thu Nov 2 10:12:13 2000

NPVU (cont.)

NPVU – ABRFC – MAE

Oct2000 DAY1 06H GRD (OBS)

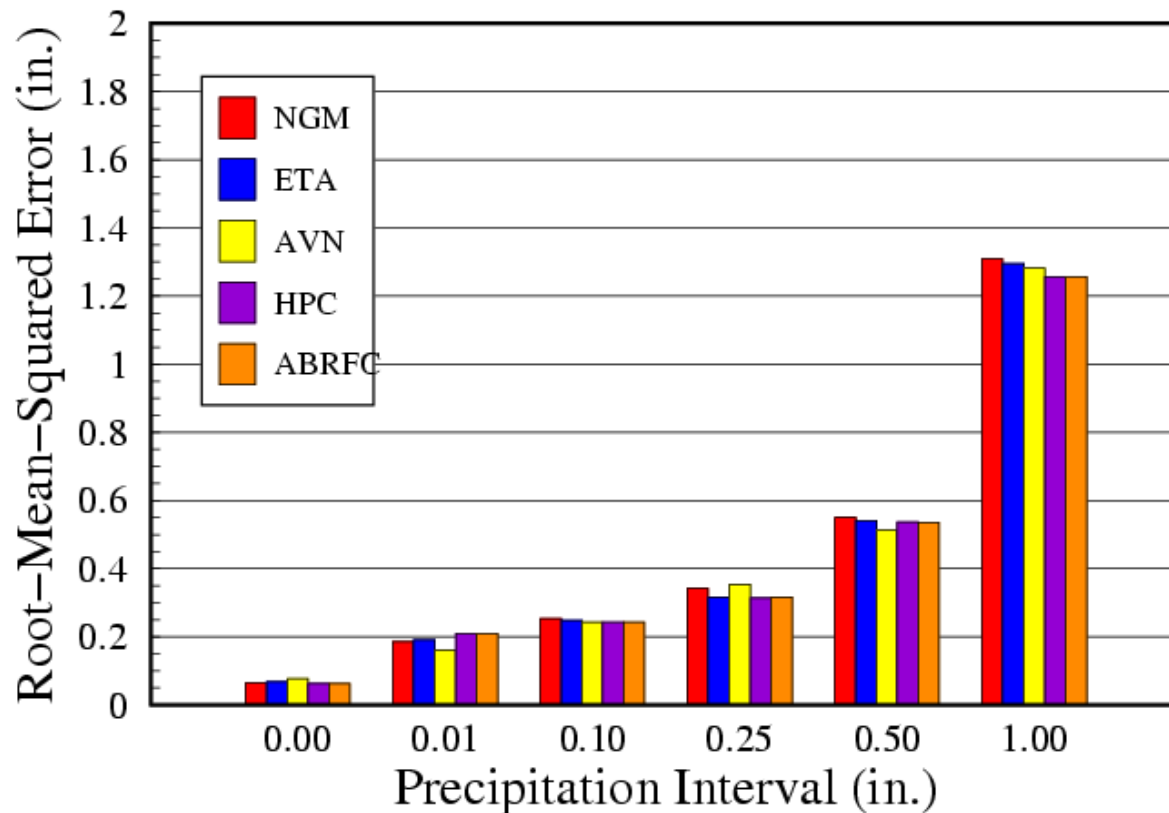


Thu Nov 2 10:11:35 2000

NPVU (cont.)

NPVU – ABRFC – RMSE

Oct2000 DAY1 06H GRD (OBS & FOR)

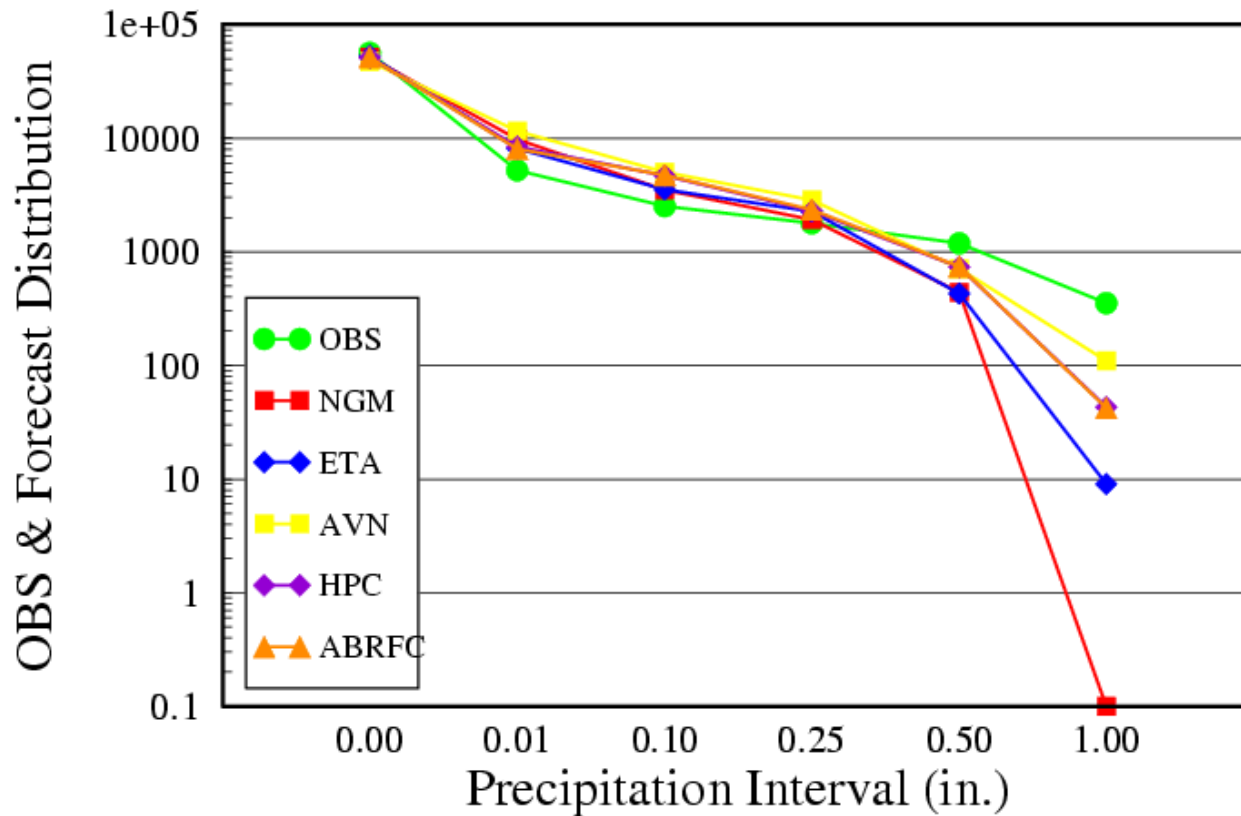


Thu Nov 2 10:12:17 2000

NPVU (cont.)

NPVU – ABRFC – DIST

Oct2000 DAY1 06H GRD (OBS)

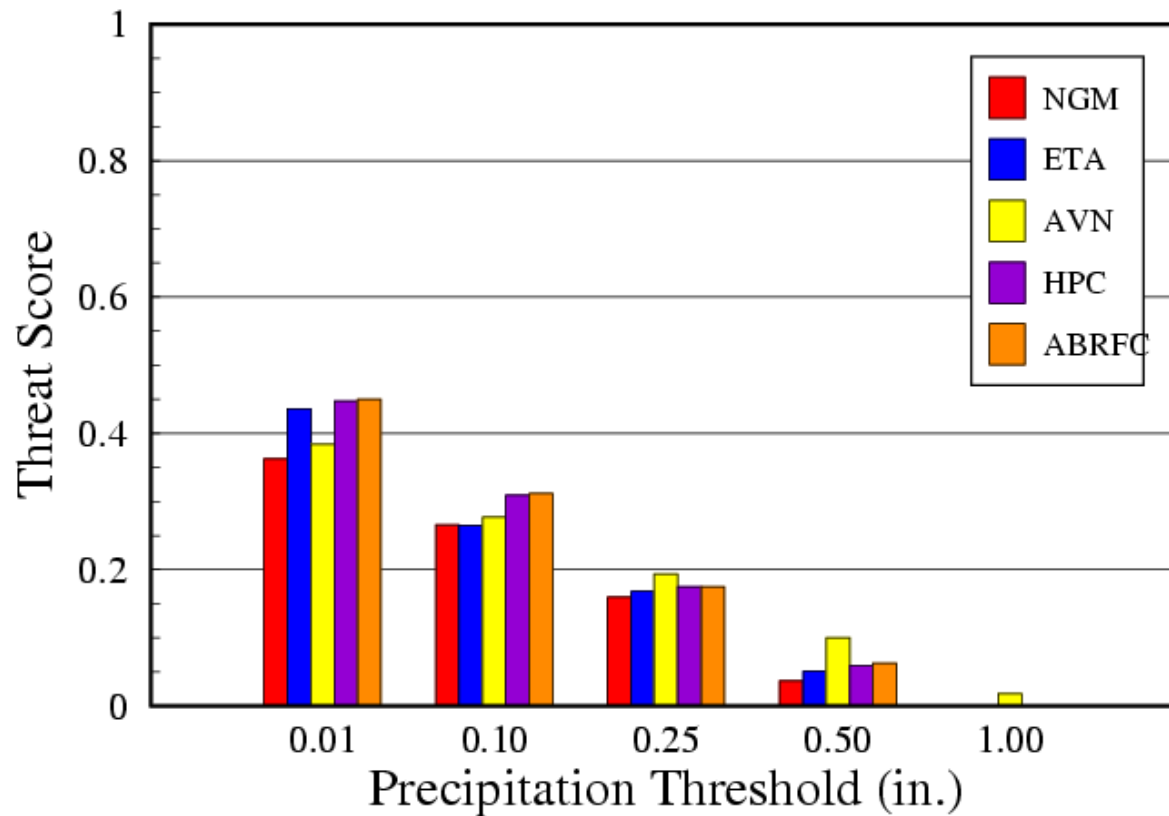


Thu Nov 2 10:11:43 2000

NPVU (cont.)

NPVU – ABRFC – TS

Oct2000 DAY1 06H GRD

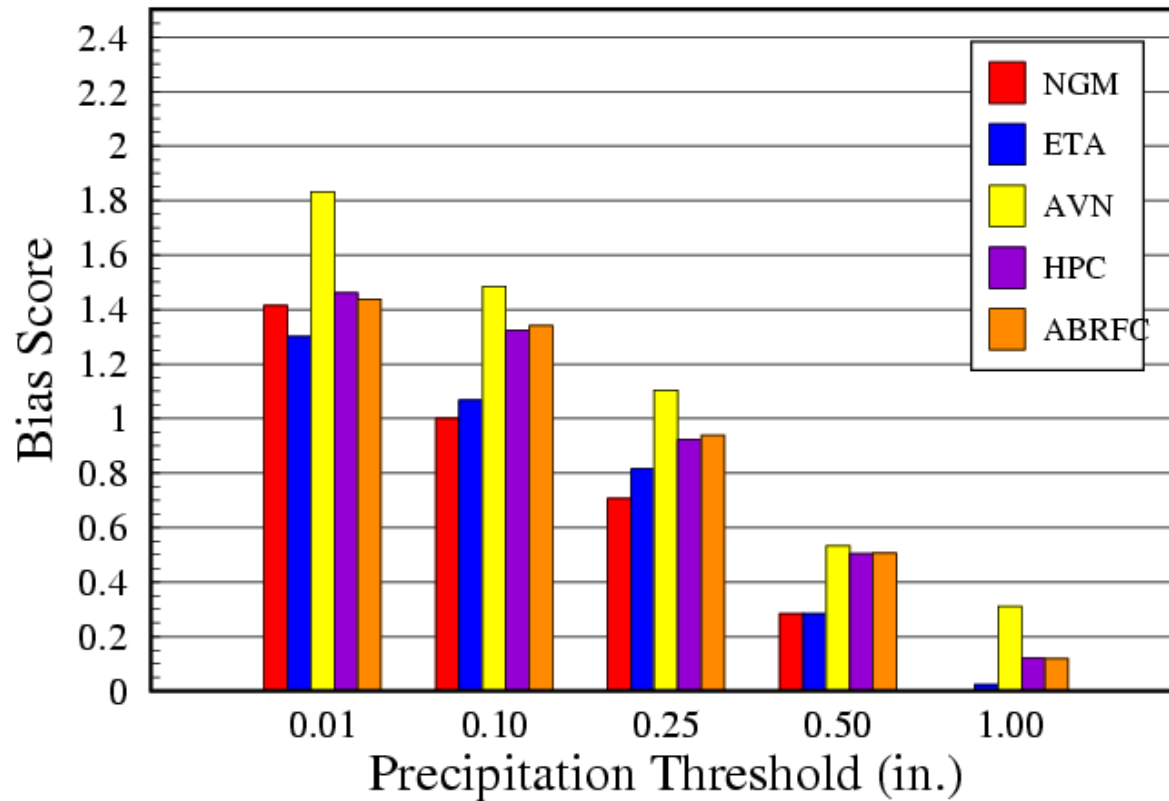


Thu Nov 2 10:10:56 2000

NPVU (cont.)

NPVU – ABRFC – BIAS

Oct2000 DAY1 06H GRD

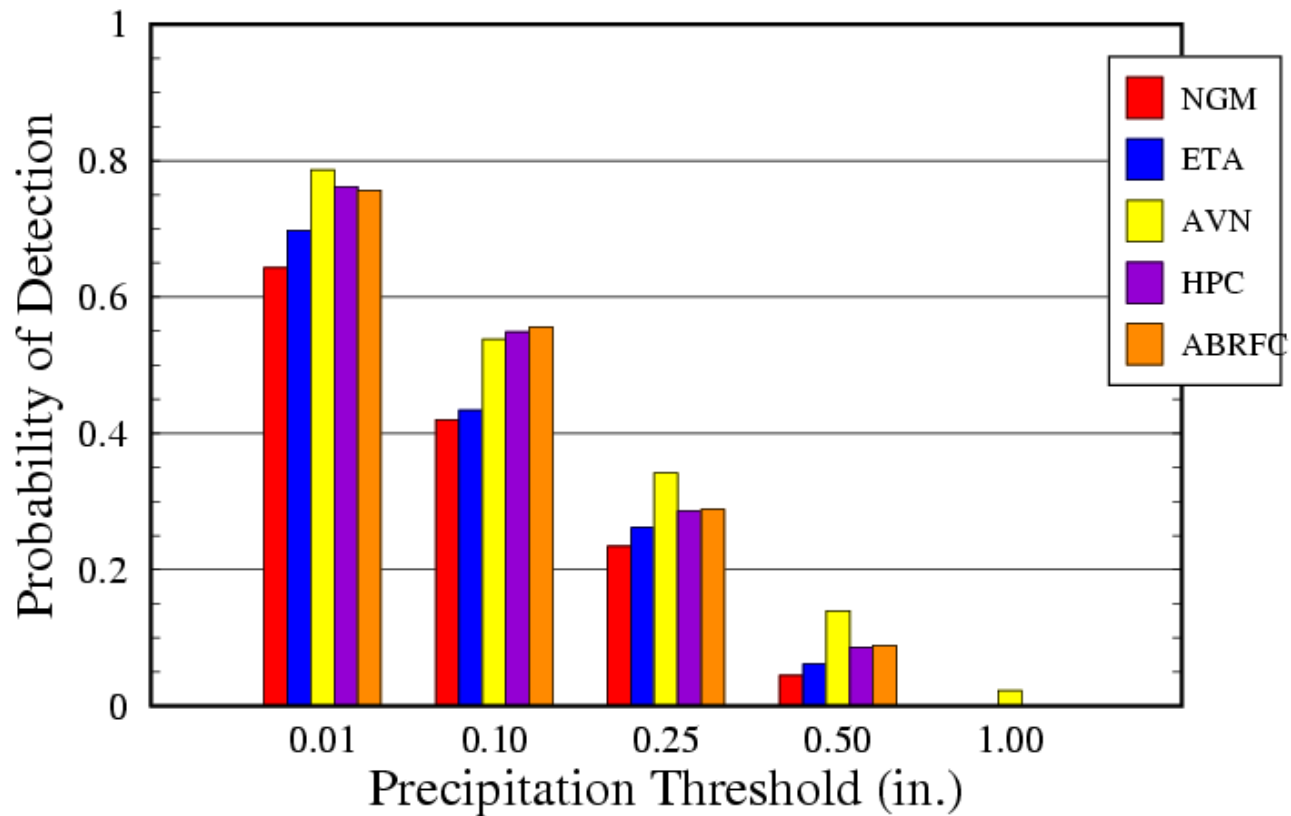


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NPVU (cont.)

NPVU – ABRFC – POD

Oct2000 DAY1 06H GRD

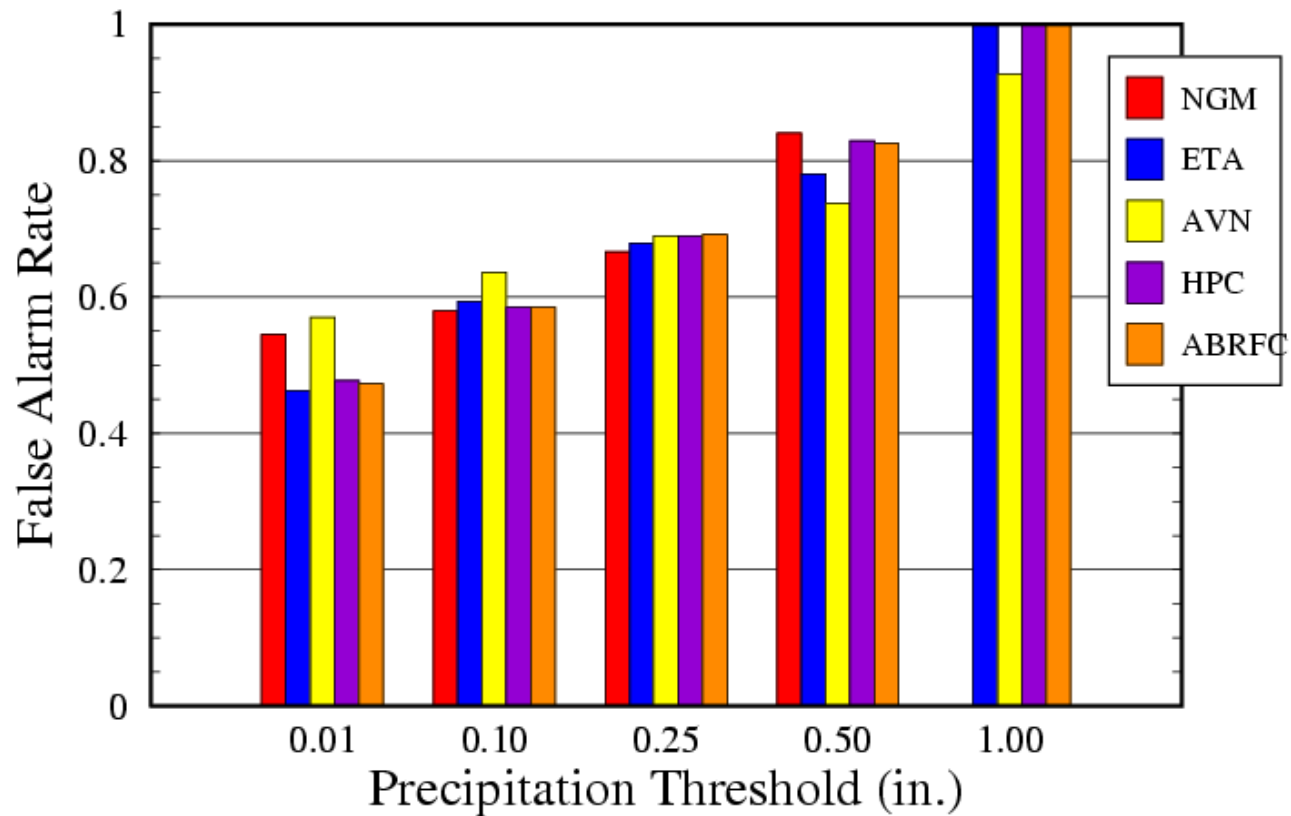


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NPVU (cont.)

NPVU – ABRFC – FAR

Oct2000 DAY1 06H GRD

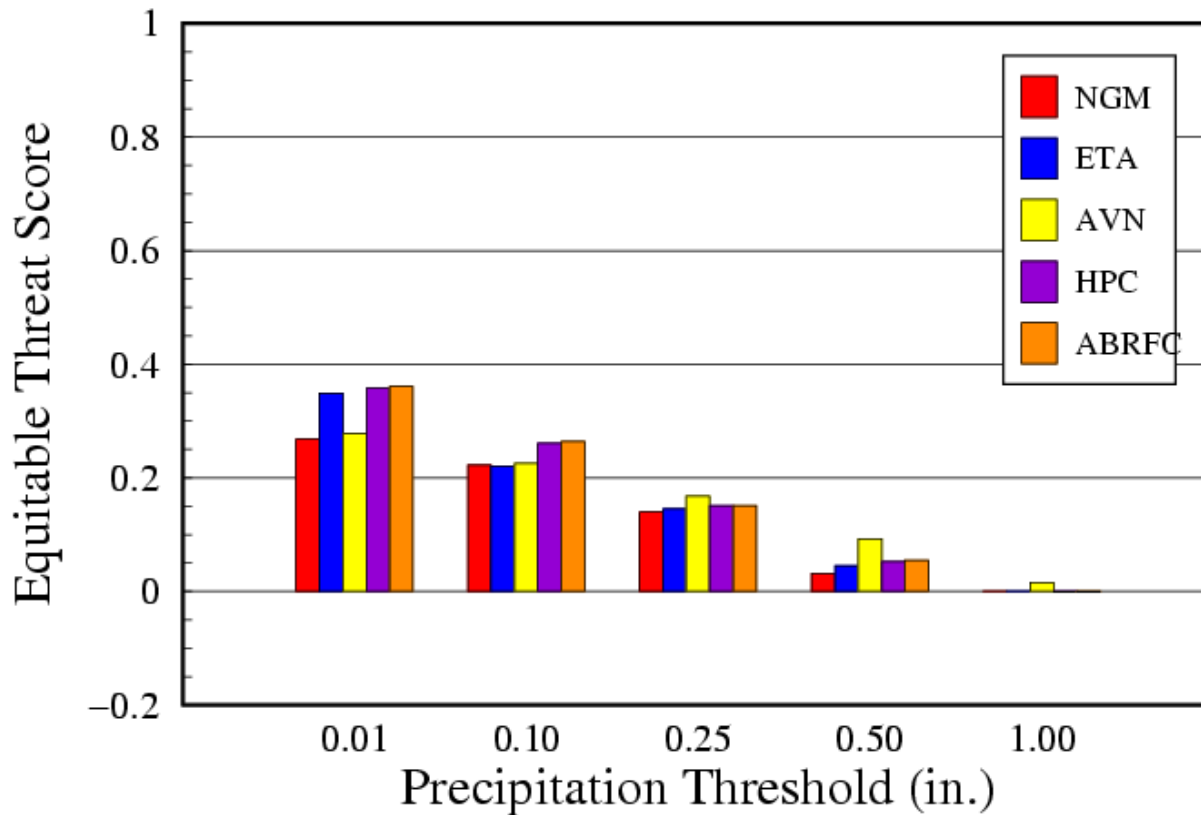


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NPVU (cont.)

NPVU – ABRFC – ETS

Oct2000 DAY1 06H GRD

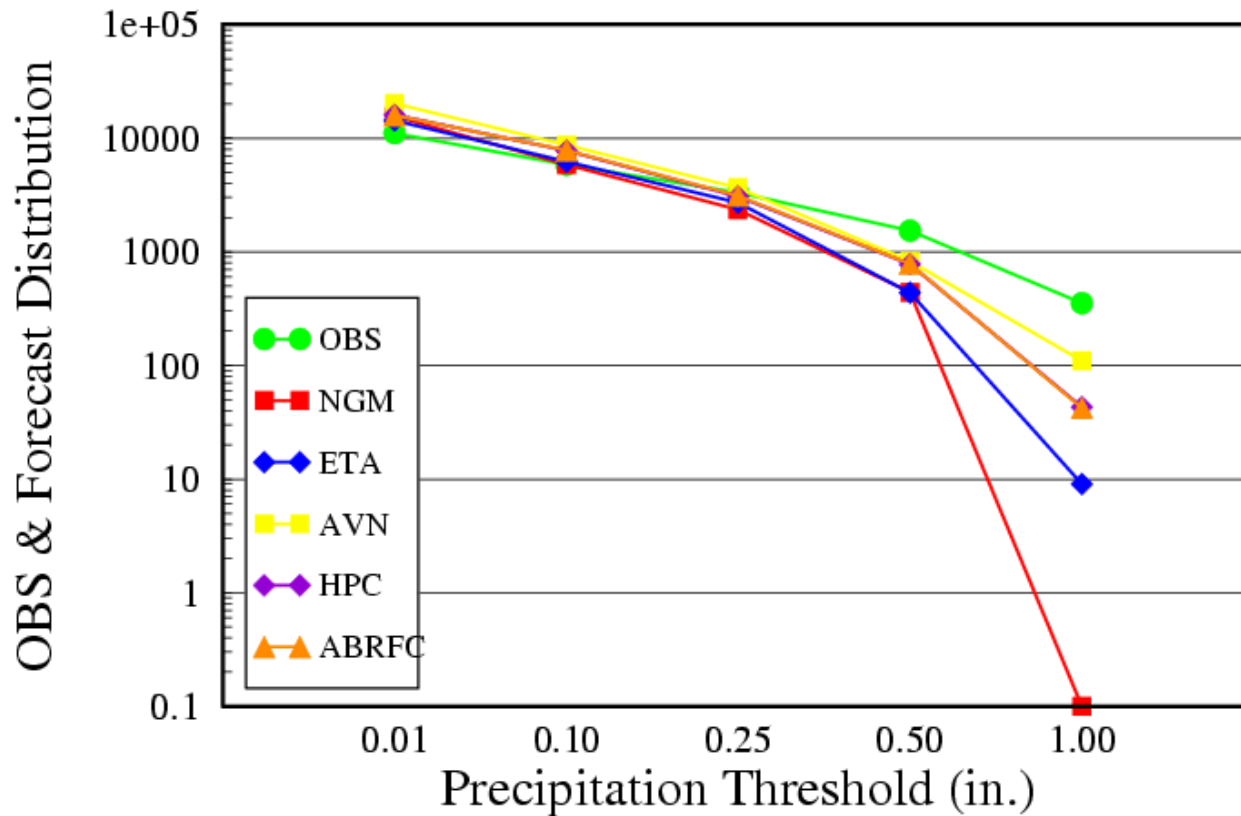


Thu Nov 2 10:11:00 2000

NPVU (cont.)

NPVU – ABRFC – DIST

Oct2000 DAY1 06H GRD



Thu Nov 2 10:11:04 2000

NPVU (cont.)

- Display & Feedback

WWW @

<http://www.hpc.ncep.noaa.gov/npvu/>

AWIPS?