NOAA's Colorado Basin River Forecast Center

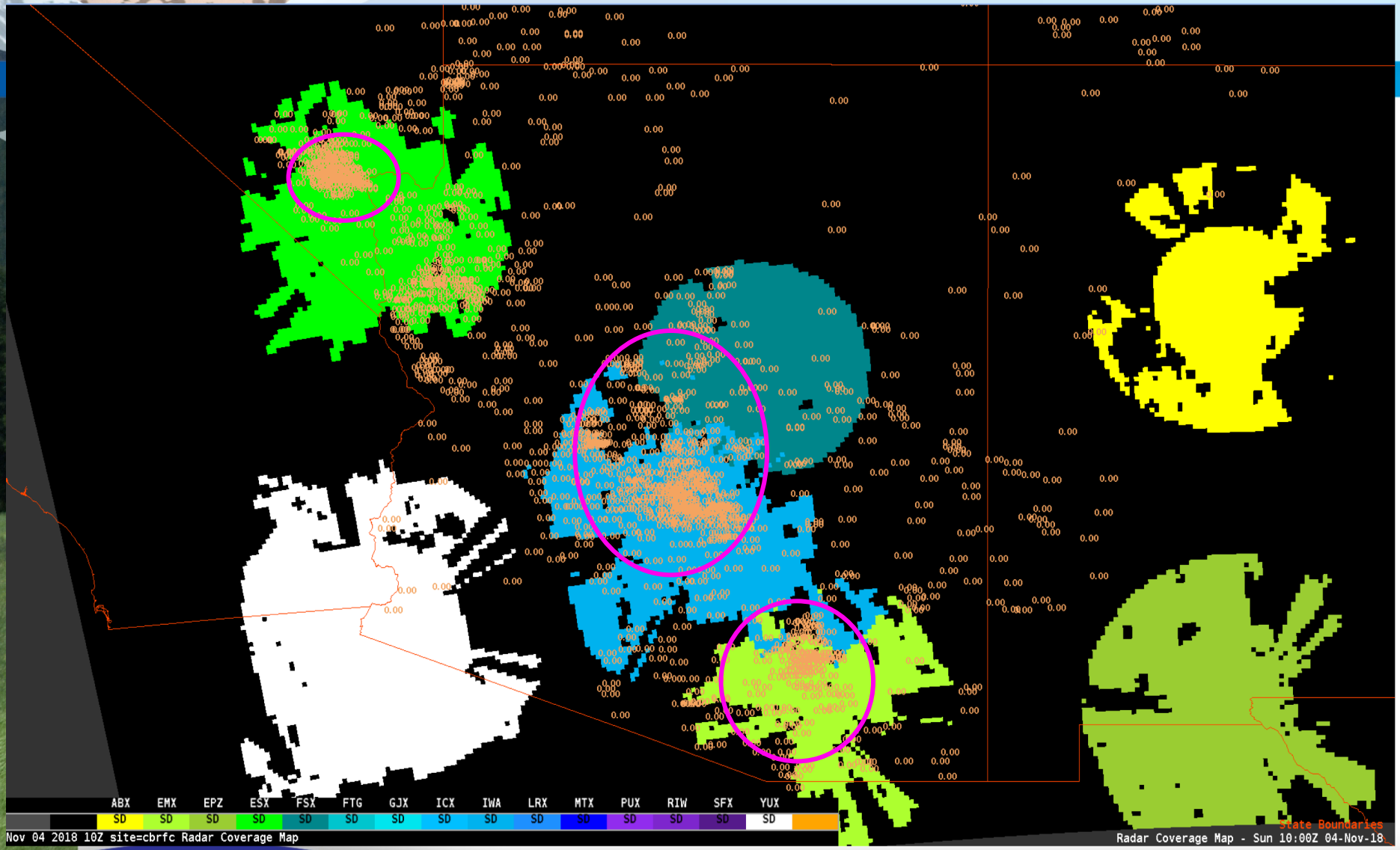
Improving Precipitation Forecasts over Lower Colorado River Basin

Zach Finch

Outline

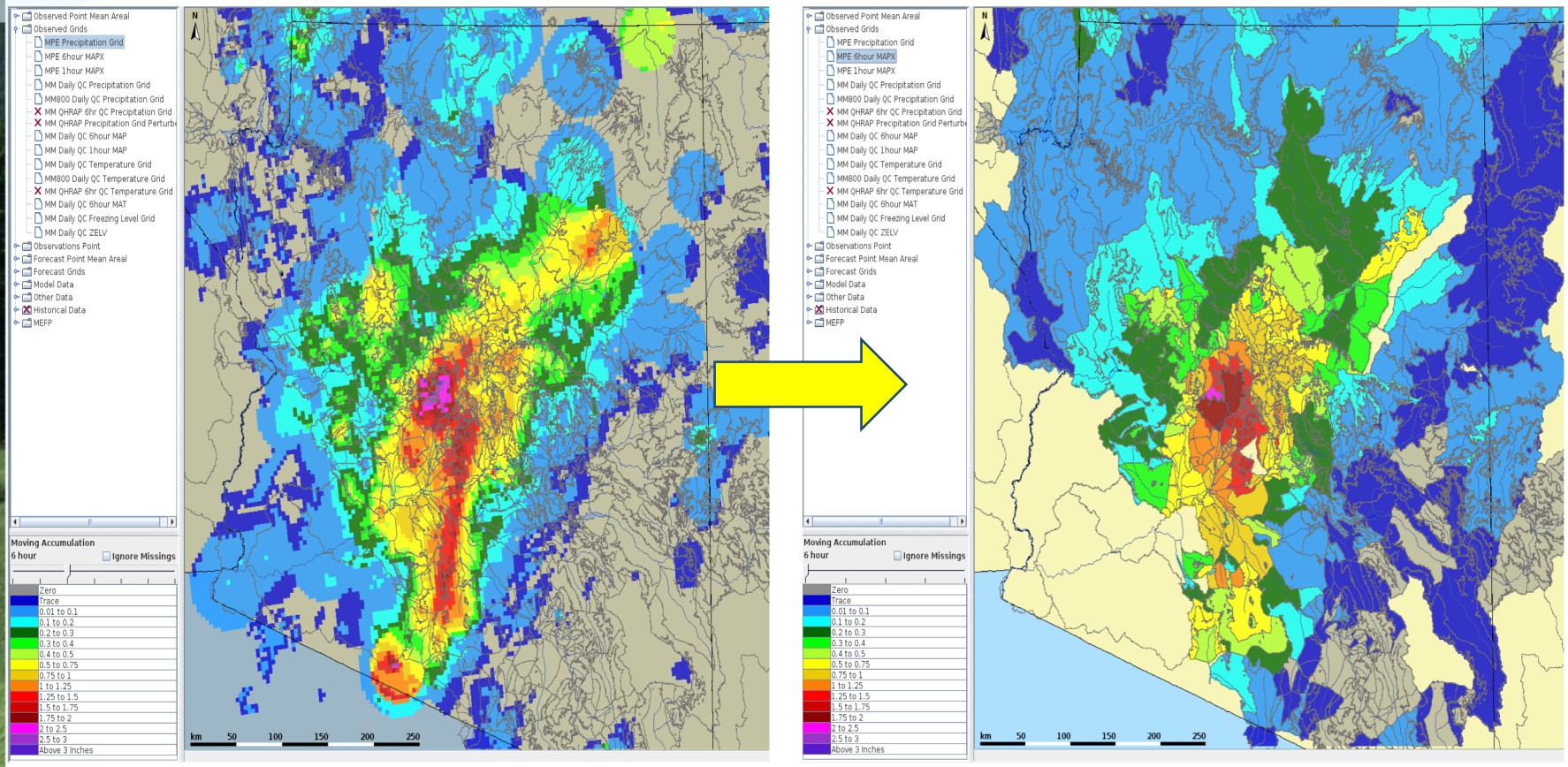
- Quantitative Precipitation Estimation (QPE) overview
- Quantitative Precipitation Forecast (QPF) verification methodology
- Verification results since July 2018
- Thoughts on CBRFC QPF moving forward

Good Radar/Gage Coverage



QPE from MPE

Gridded **MAP**



Radar derived precipitation (dual-pol) is combined with gages in MPE to do bias correction, and then generate a final QPE product that is sent to our hydrologic model.

QPF from Different Models

- Weather Prediction Center (WPC) - Produces 6-hr QPF out to seven days. **Considered the “benchmark” as it is the current starting point for CBRFC fcsts.
- National Blend of Models (NBM) - A statistical blend of many weather models with 6-hr QPF out to ten days.
- High Resolution Rapid Refresh (HRRR) - A high resolution, hourly updated, weather model with 1-hr/6-hr QPF out to 18 hours.
- NBM/HRRR - A 50/50 blend of the two models.

Verification Methodology

- *Short-term* verification of QPF from morning (12Z) models since July 2018.
- Two different QPF durations considered:
  QPF06 - 6 hourly QPF out to 18 hours (12-18Z,18-00Z,00-06Z)
  QPF18 - 18 hourly QPF (12-06Z)

Verification Stats

a) ***Equitable Threat Score (ETS)***

Measures the fraction of observed and/or forecast events that were correctly predicted. **Range:** -1/3 to 1, 0 indicates no skill. **Perfect score:** 1

b) ***Frequency Bias (FreqBias)***

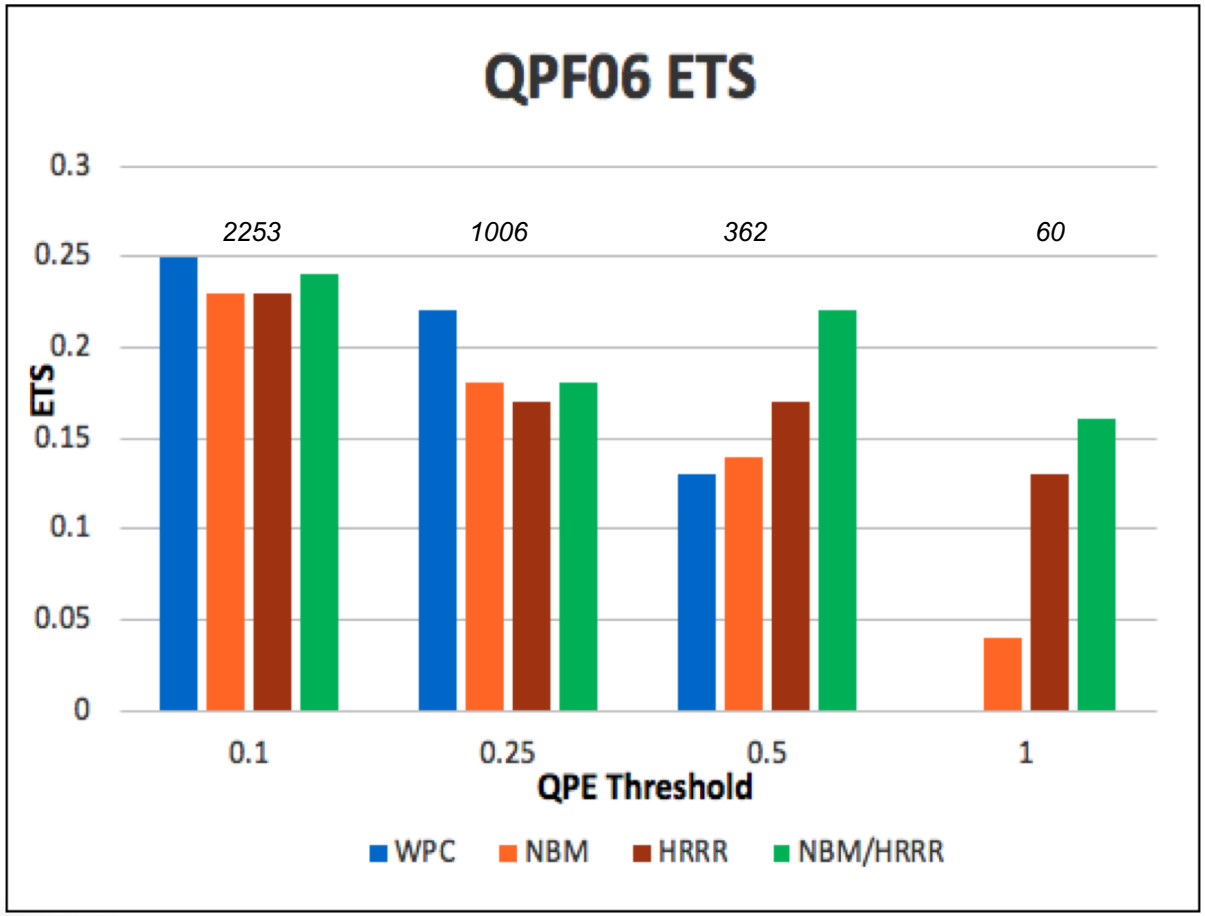
Measures the ratio of the frequency of forecast events to the frequency of observed events. **Range:** Underfcst (<1) or Overfcst(>1). **Perfect score:** 1

b) ***Mean Absolute Error (MAE)***

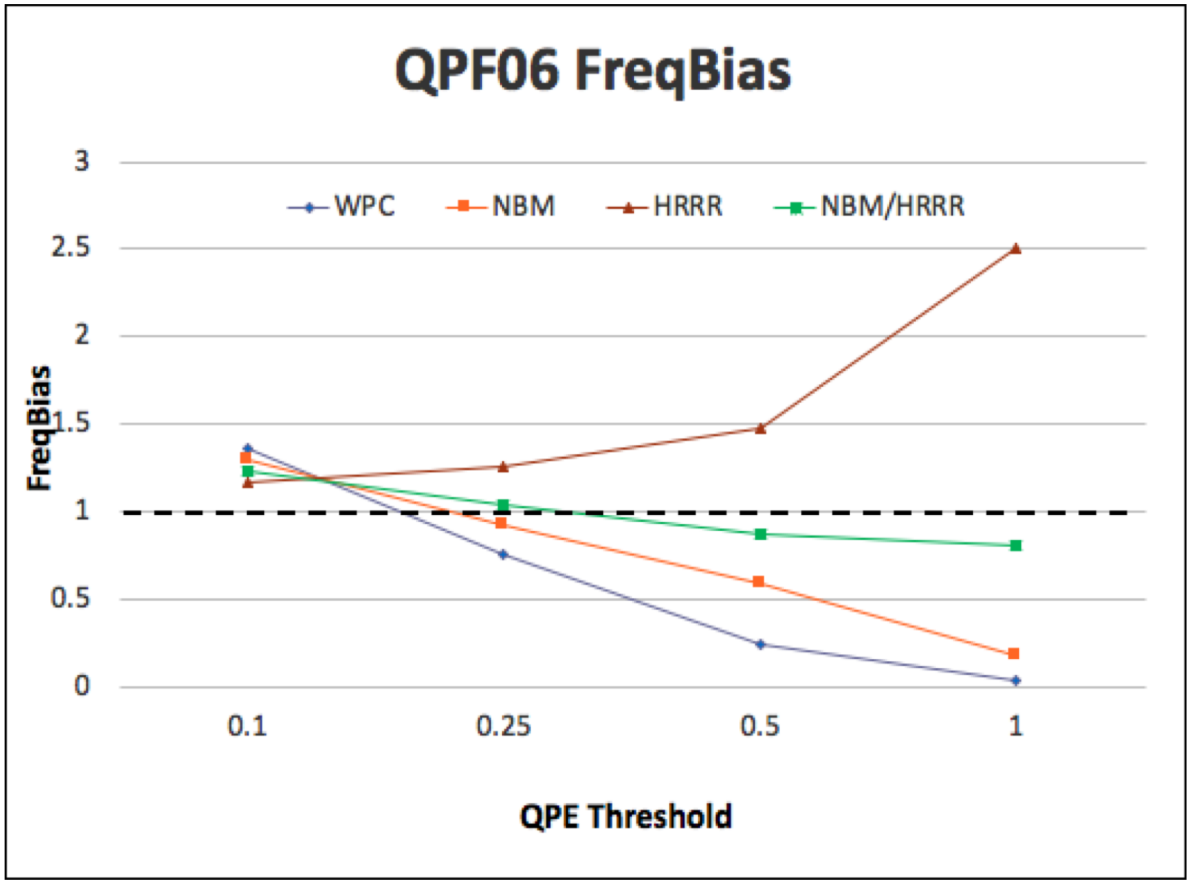
The average magnitude of the forecast errors.

Range: 0 to infinity. **Perfect score:** 0

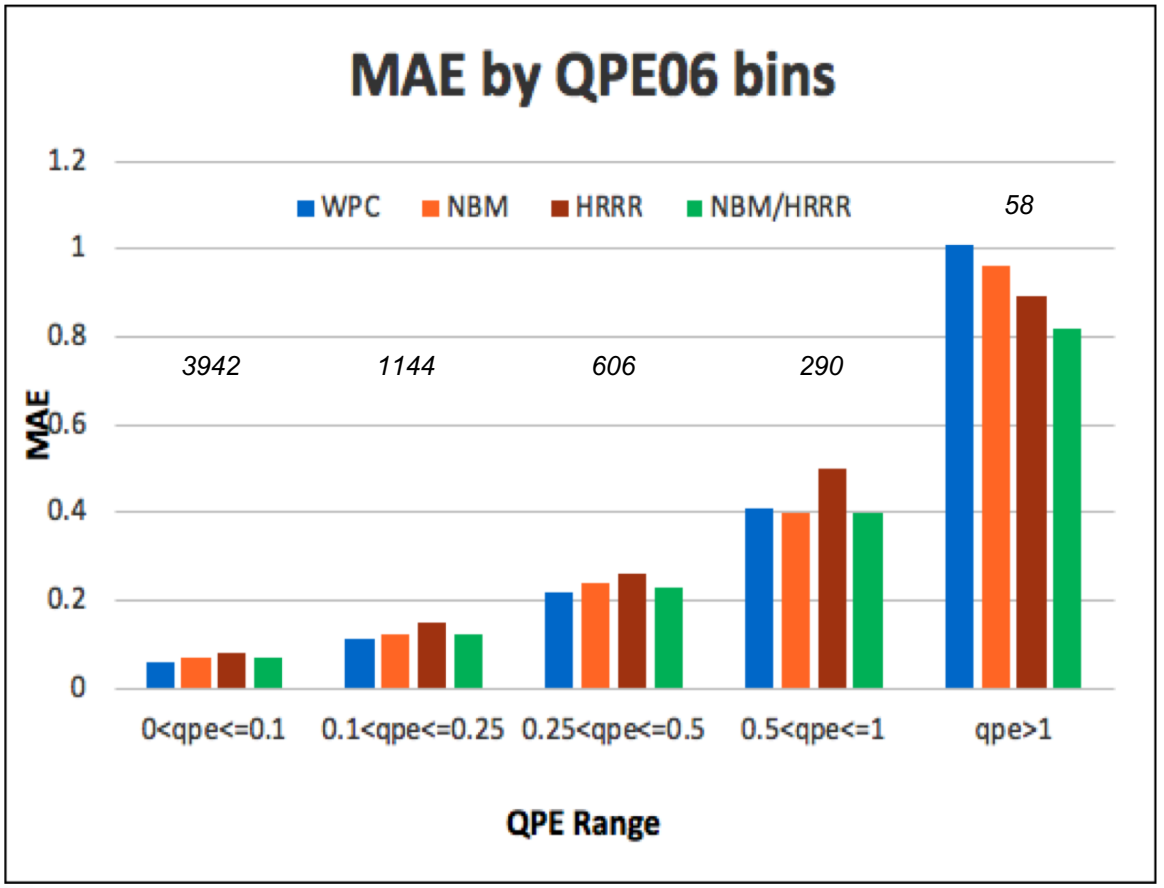
Equitable Threat Score



Frequency Bias



Mean Absolute Error



Summary

- WPC and NBM do well at lower precip thresholds (<0.5 inch), but struggles at higher precip amounts due to its tendency to underforecast. On the other hand, the HRRR overforecasts precip events at all thresholds. This causes poorer relative performance at low end events, but better skill scores at heavier, high-impact events (>1inch).

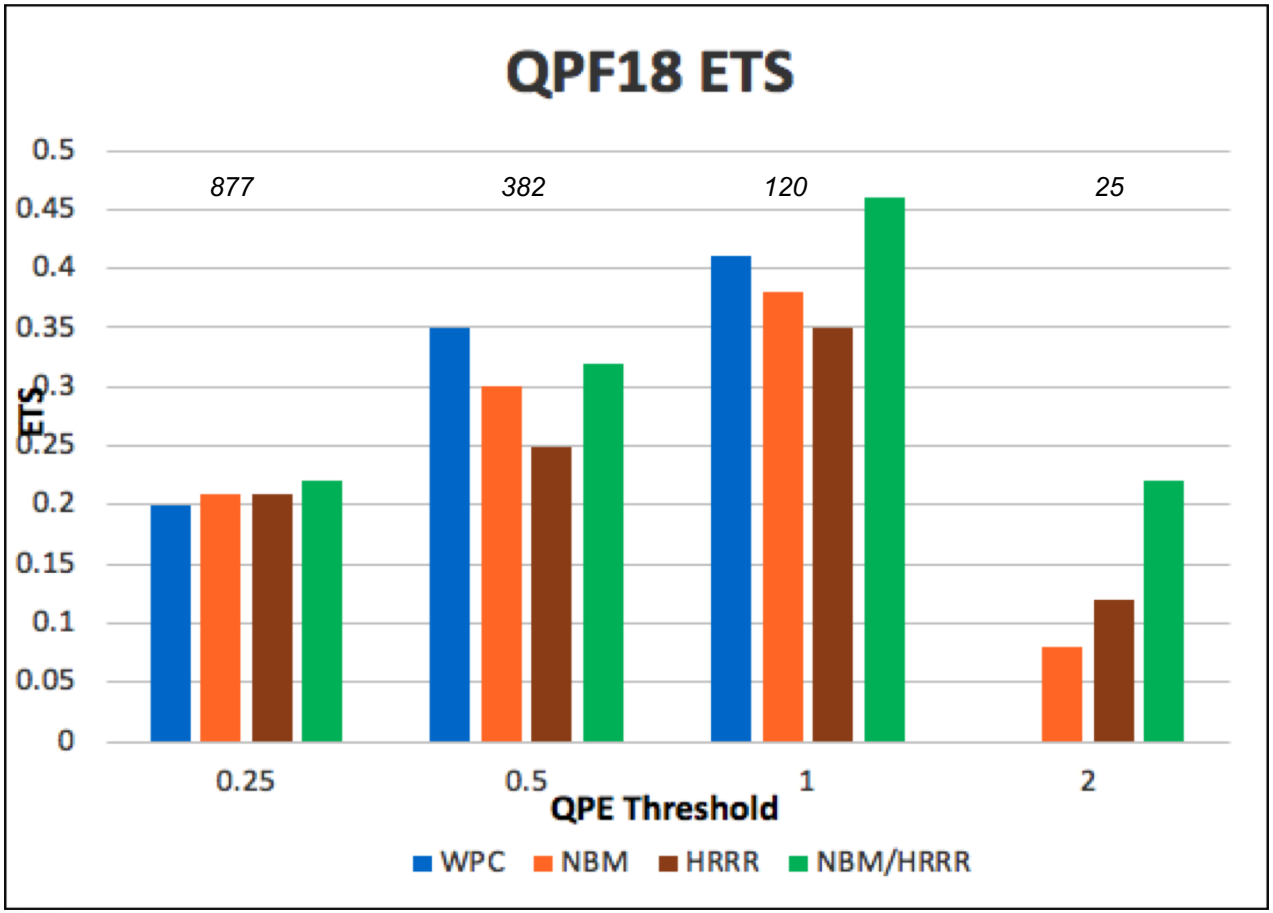
- A blend of the NBM/HRRR has promise as a starting point for CBRFC fcsts. This is due to its superior stats, particularly when precip is highest. Alternatively, could examine HRRR on grid level to create a bias-corrected HRRR model using the MPE.

- We need more rain events, especially heavier ones. Will continue to archive model forecasts and observations, and analyze through the winter/spring.

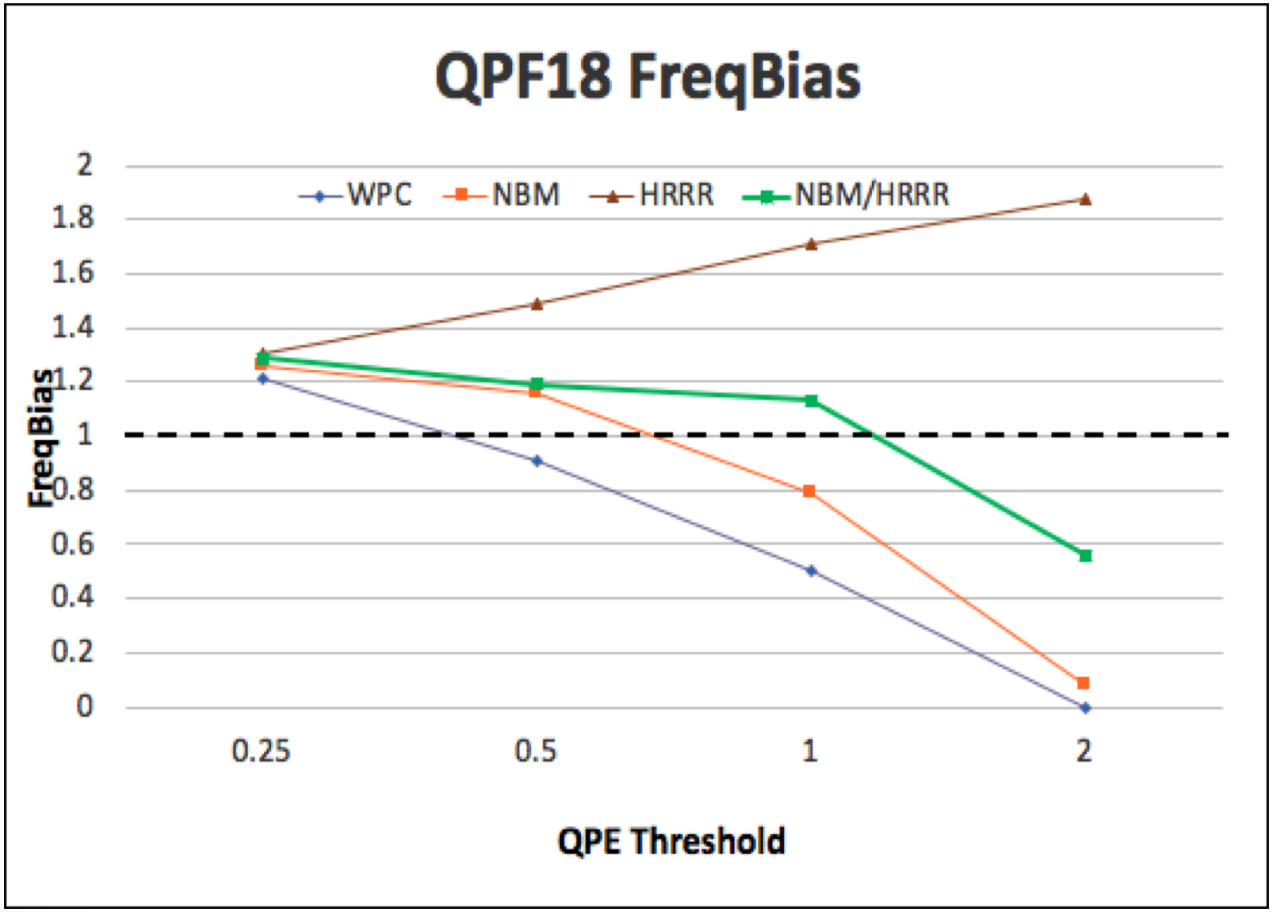
- We are exploring using the hourly QPF from the short term models to improve warm season hydrograph forecasts.

Extra Slides

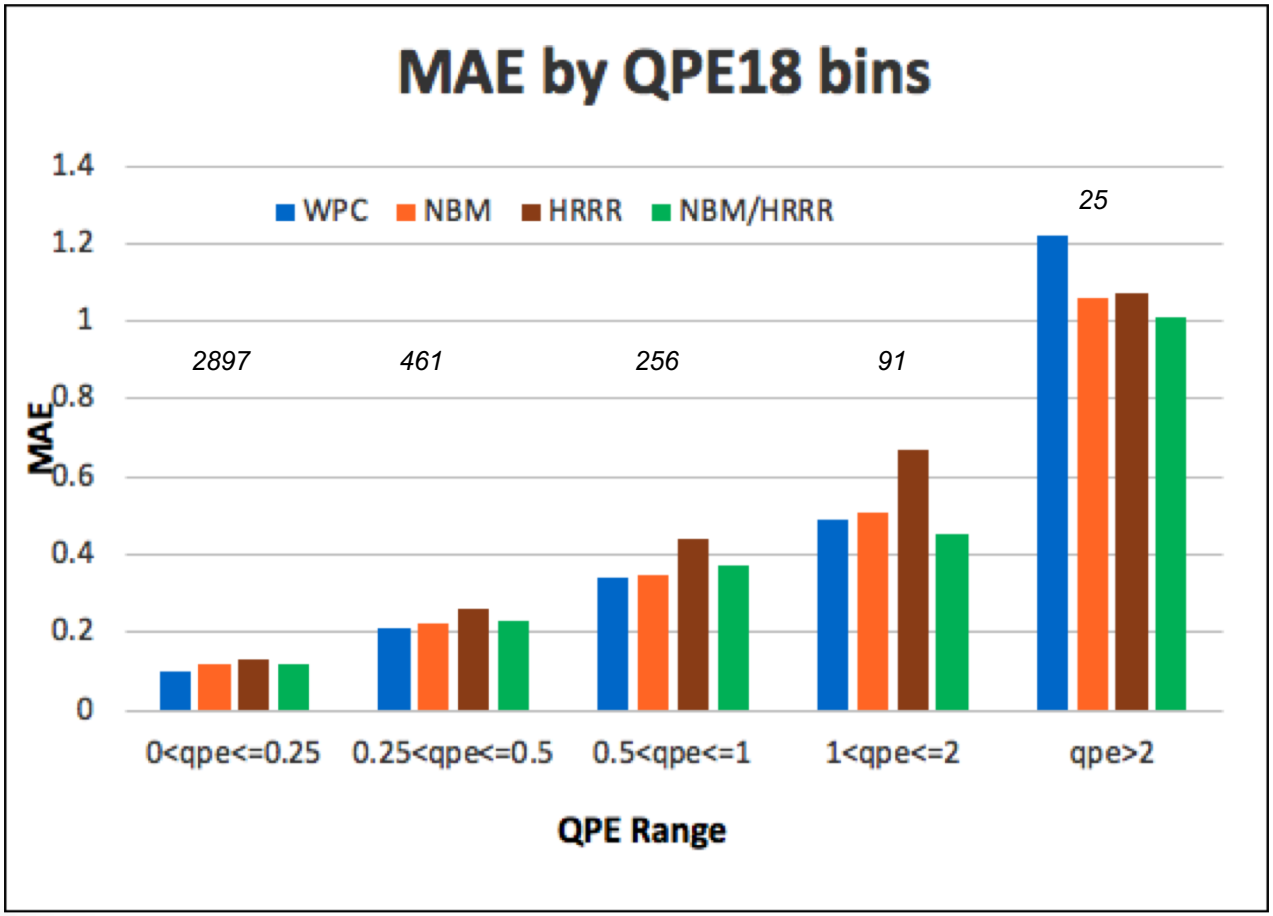
QPF18 ETS


QPF18 ETS
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
ETS
877
382
120
25
0.25
0.5
1
2
QPE Threshold
WPC
NBM
HRRR
NBM/HRRR

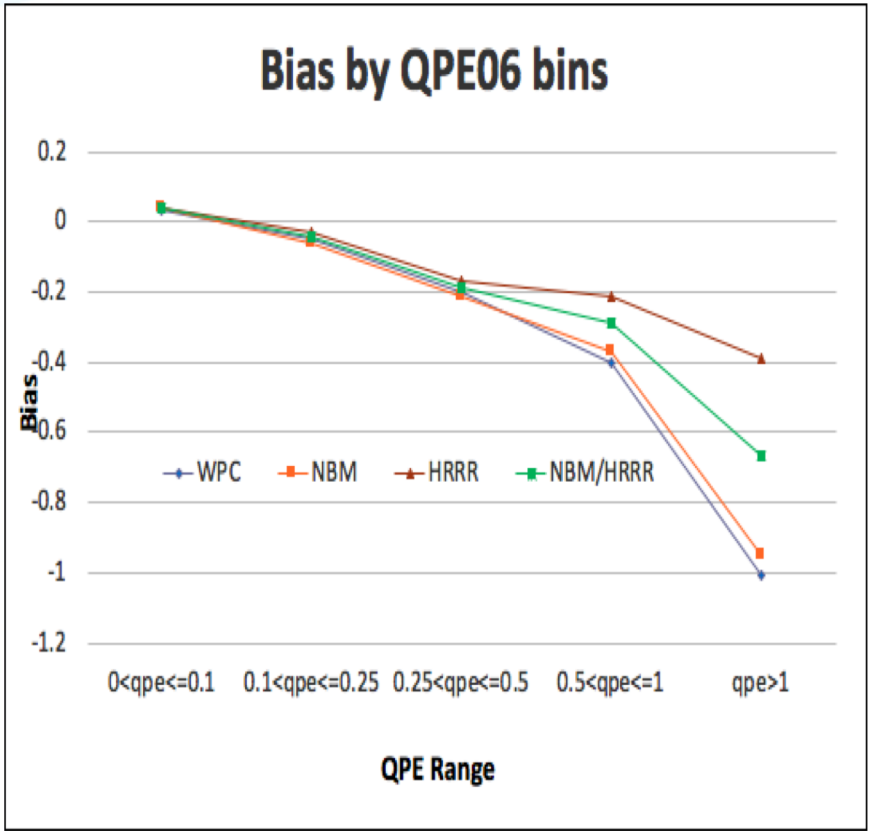
QPF18 FreqBias

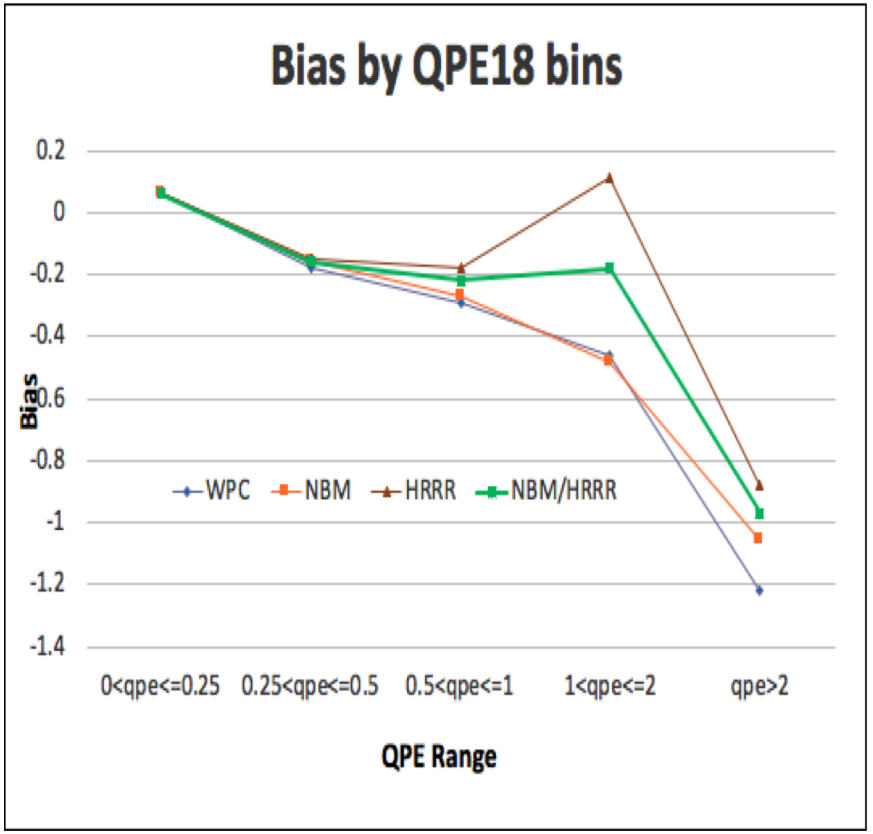


QPF18 MAE


MAE by QPE18 bins
1.4
1.2
1
0.8
0.6
0.4
0.2
0
MAE
WPC
NBM
HRRR
NBM/HRRR
2897
461
256
91
25
0<qpe<=0.25
0.25<qpe<=0.5
0.5<qpe<=1
1<qpe<=2
qpe>2
QPE Range

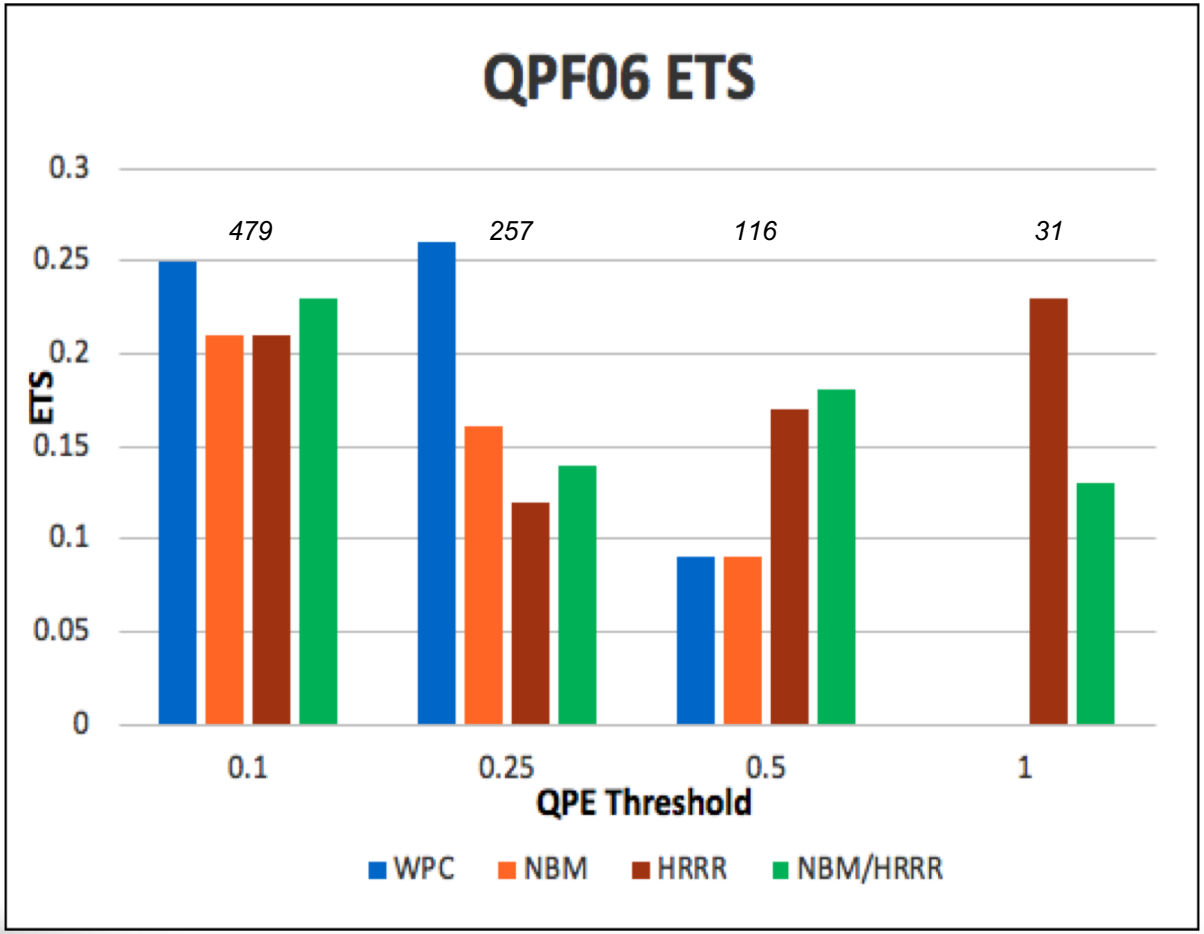
Bias by QPE Bin



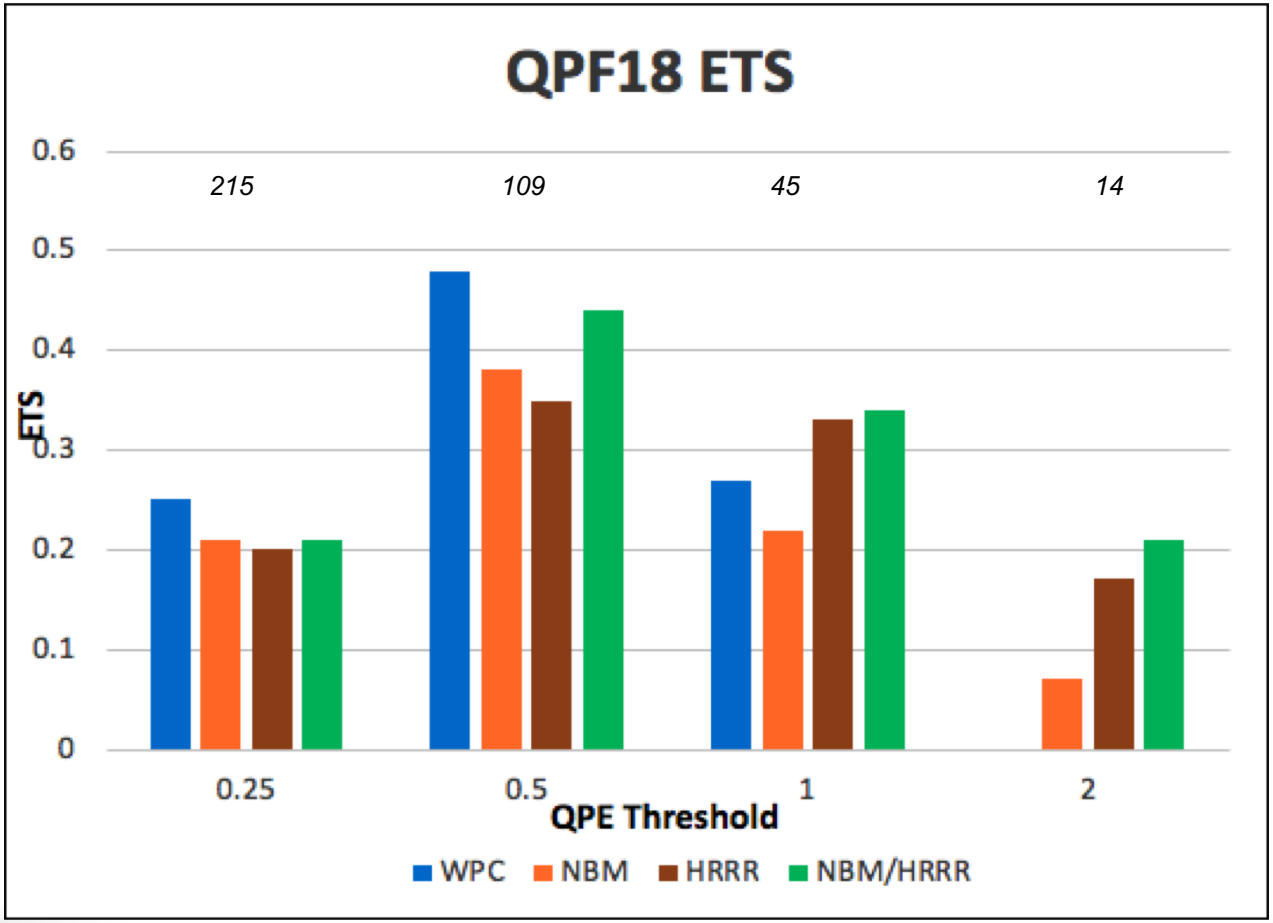


Phoenix Area Only
(For Maricopa County Flood Control)

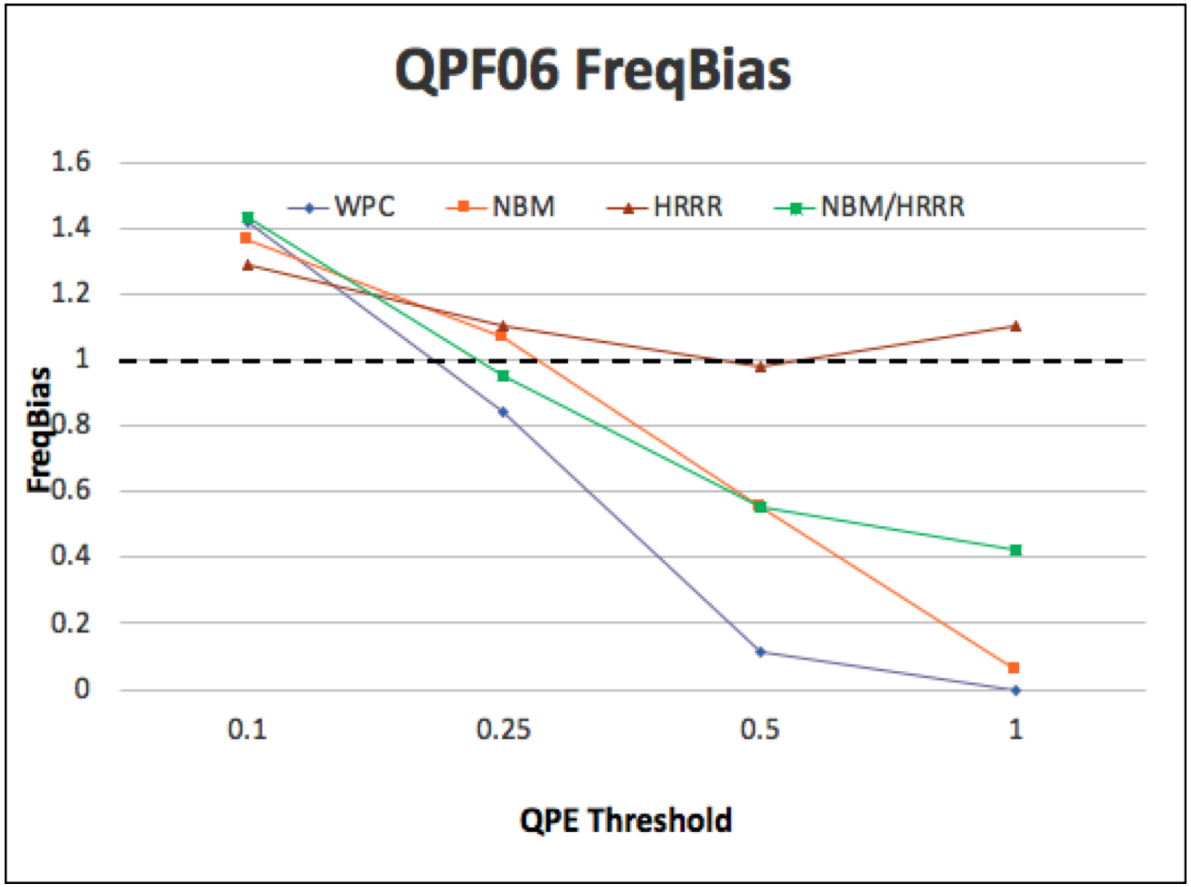
Equitable Threat Score



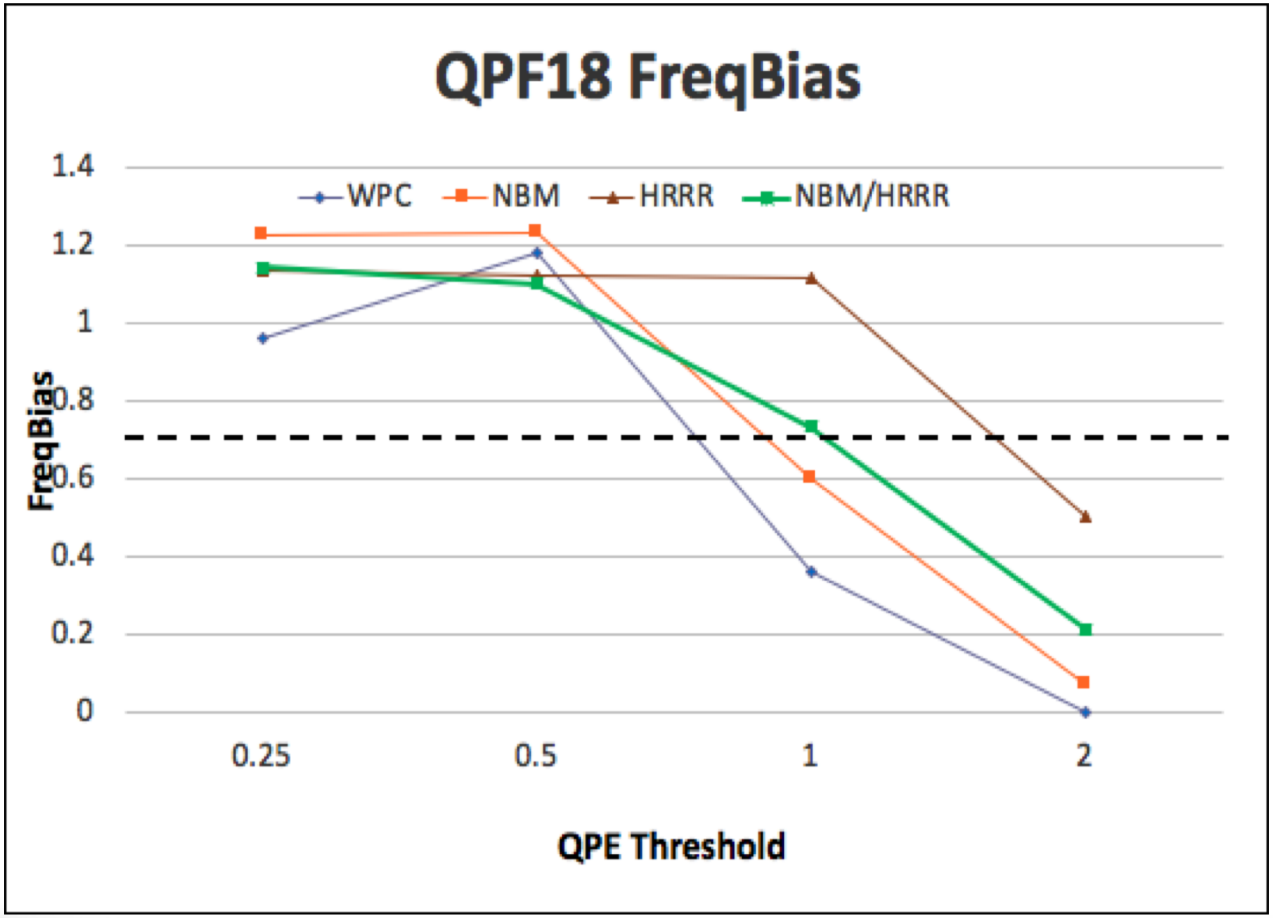
QPF18 ETS


QPF18 ETS
0.6
0.5
0.4
0.3
0.2
0.1
0
ETS
215
109
45
14
0.25
0.5
1
2
QPE Threshold
WPC
NBM
HRRR
NBM/HRRR

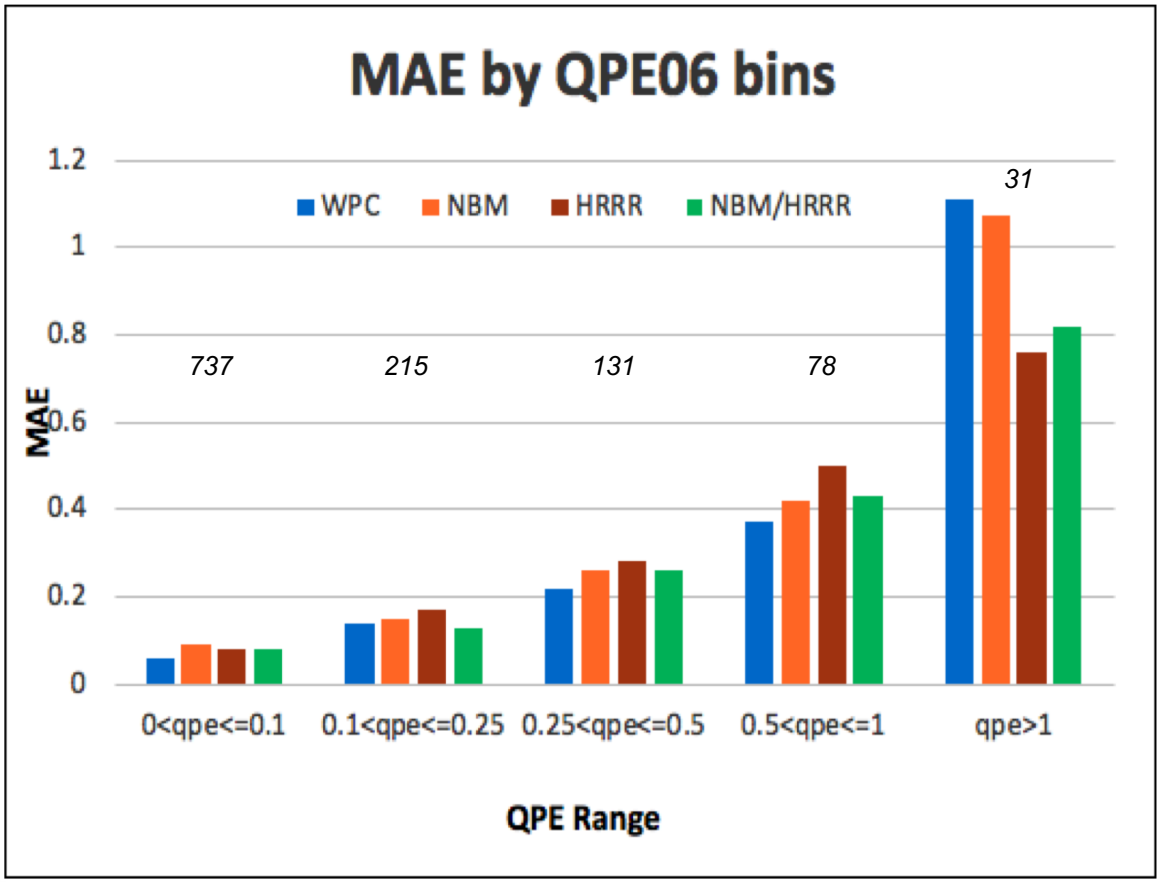
Frequency Bias



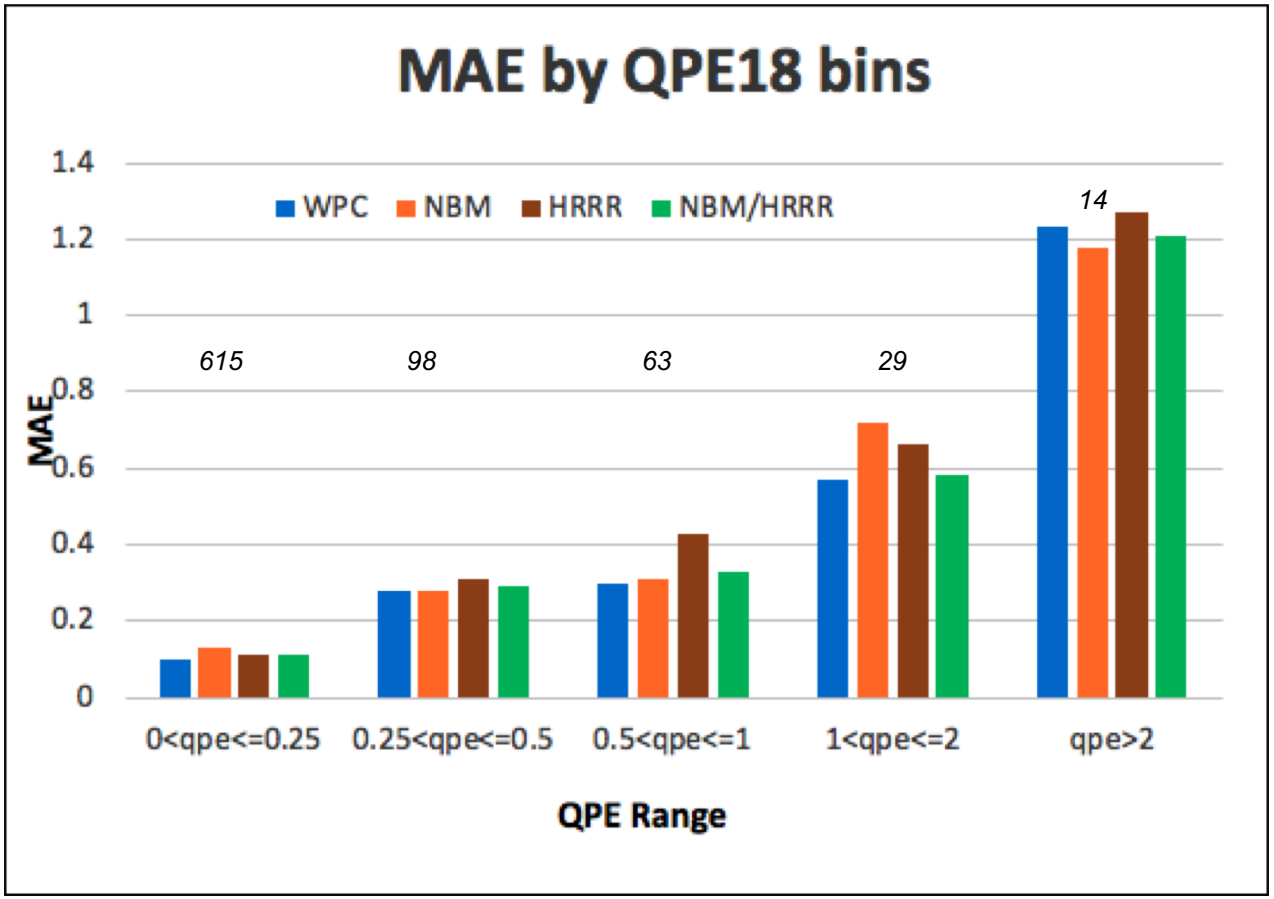
QPF18 FreqBias



Mean Absolute Error



QPF18 MAE


MAE by QPE18 bins
WPC
NBM
HRRR
NBM/HRRR
MAE
1.4
1.2
1
0.8
0.6
0.4
0.2
0
615
98
63
29
14
0<qpe<=0.25
0.25<qpe<=0.5
0.5<qpe<=1
1<qpe<=2
qpe>2
QPE Range

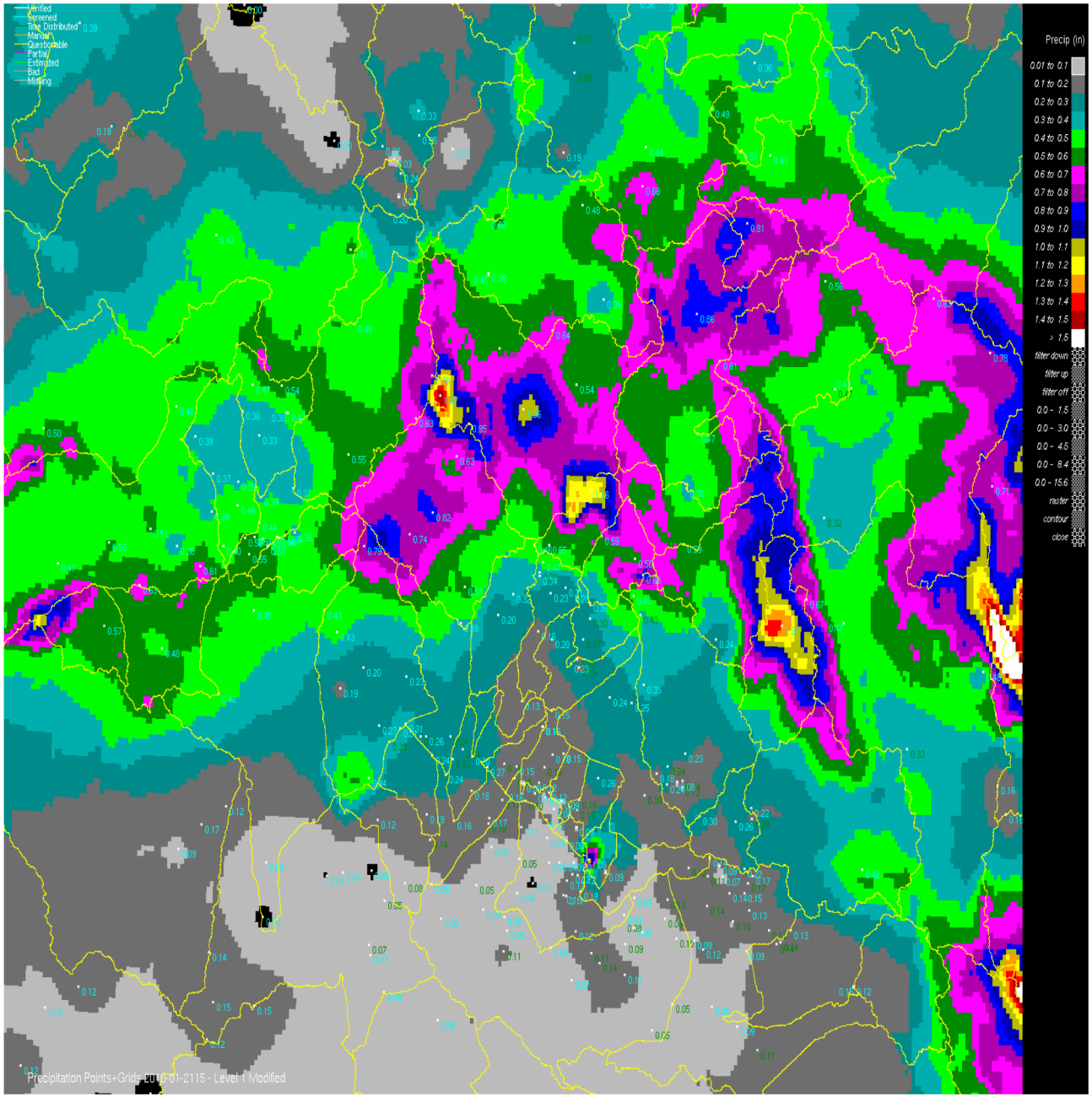
Major Projects in the Lower Colorado River Basin

Quality control of gage precipitation for calibration

Re-calibration effort

QC of Precipitation Information for Calibration

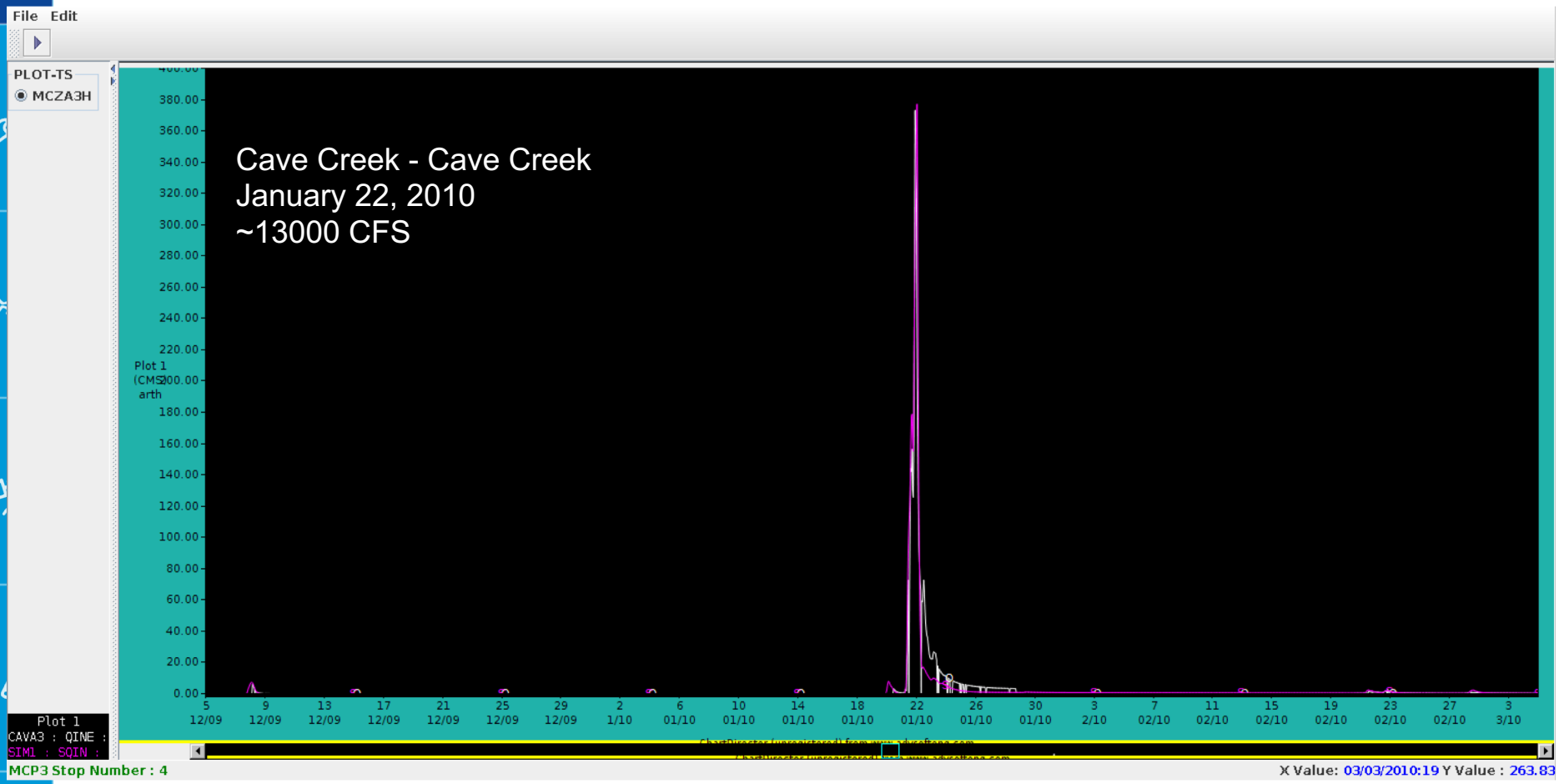
- Precip/Temp gages were QC'd from Oct. 2000 through current
- ALL available gages were used
- 3-hourly, gridded precip and temp fields were created using PRISM
- 3-hourly MAPs and MATs generated
- Iterative process
  - Additional QCing is easy
  - Subtle errors can be identified during the calibration process and corrected
- Update record monthly in real-time
- Grids are a starting point for future distributed modeling and are available on our FTP site

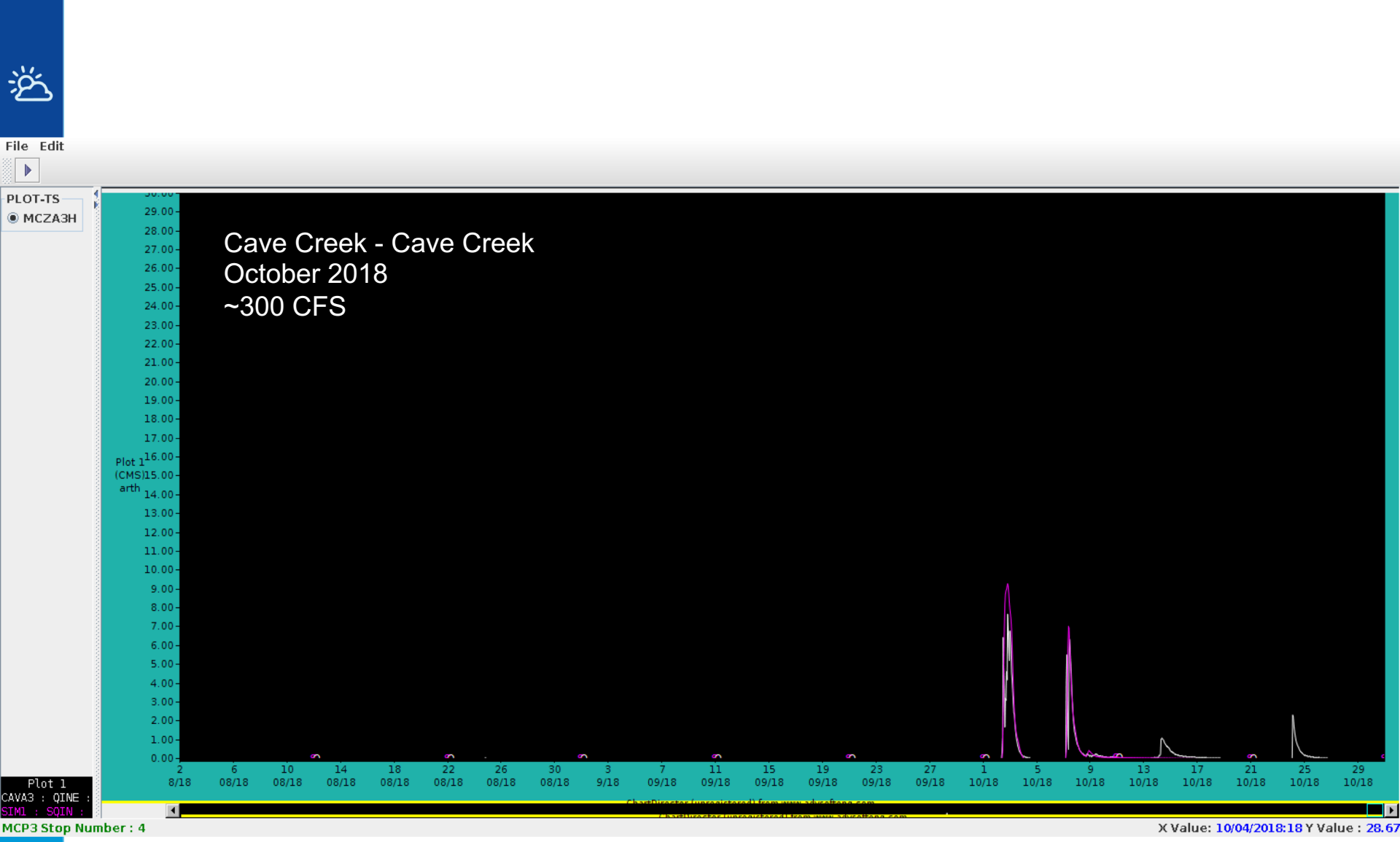


3 hourly precipitation ending 01/22/2010 18Z

Re-calibration Effort

- Entire Lower Colorado River Basin will be calibrated using the 3-hourly gridded data
- Will closely match operational data set
  - Operational data is hourly, includes bias-adjusted dual pol radar estimate
  - Especially true in the winter when radar is trimmed below the freezing level and 12,000 feet
- Use of all data significantly improves simulations
- Will add more basins
- Areas that utilize ESP (Salt, Verde, and Gila)
  - Will bias adjust MAP and MAT data prior to 2000 using overlapping data
  - Will allow full use of 1981-2015 period


File Edit
PLOT-TS
MCZA3H
Cave Creek - Cave Creek
January 22, 2010
~13000 CFS
Plot 1
(CMS)
arth
380.00
360.00
340.00
320.00
300.00
280.00
260.00
240.00
220.00
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
5 12/09
9 12/09
13 12/09
17 12/09
21 12/09
25 12/09
29 12/09
2 1/10
6 01/10
10 01/10
14 01/10
18 01/10
22 01/10
26 01/10
30 01/10
3 2/10
7 02/10
11 02/10
15 02/10
19 02/10
23 02/10
27 02/10
3 3/10
Plot 1
CAVA3 : QINE :
SIM1 : SQIN :
MCP3 Stop Number : 4
X Value: 03/03/2010:19 Y Value : 263.83


File Edit
PLOT-TS
MCZA3H
Cave Creek - Cave Creek
October 2018
~300 CFS
Plot 1
(CMS)
arth
29.00
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
2 8/18
6 08/18
10 08/18
14 08/18
18 08/18
22 08/18
26 08/18
30 08/18
3 9/18
7 09/18
11 09/18
15 09/18
19 09/18
23 09/18
27 09/18
1 10/18
5 10/18
9 10/18
13 10/18
17 10/18
21 10/18
25 10/18
29 10/18
Plot 1
CAVA3 : QINE :
SIM1 : SQIN :
MCP3 Stop Number : 4
X Value: 10/04/2018:18 Y Value : 28.67