MBRFC Case Study

WFO-TFX asks: How good are the daily forecasts?

National Verification Case Studies Team

September 25, 2008

Background

- 7 years ago WFO-TFX asked the question:
How good are the daily forecasts?

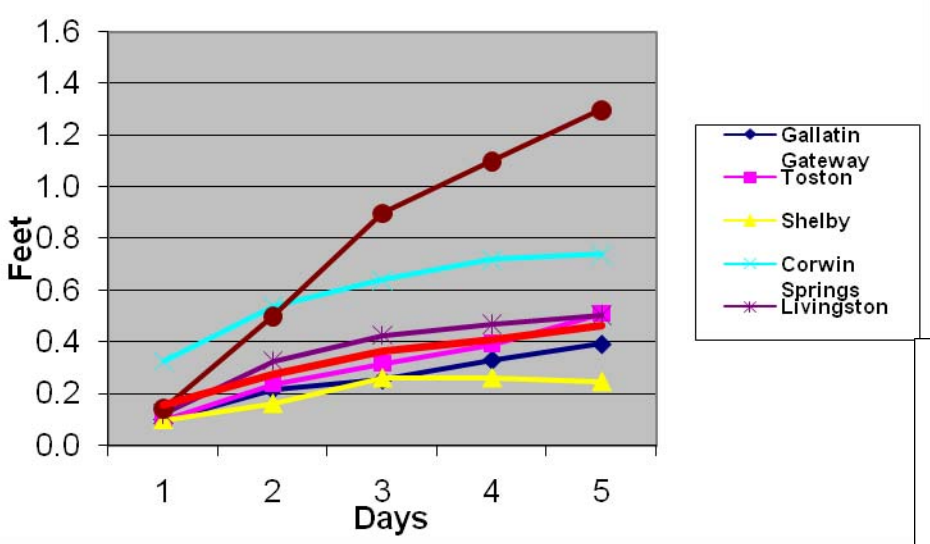
- at that time 6 stations were looked at, these were:
GLGM8, SHLM8 & TOSM8 for Upper Missouri Forecast Group
CORM8, LIVM8 & BILM8 for the Yellowstone Forecast Group

- using local verification software, MAE for each station on a monthly basis for the years 1998 thru 2001 were computed

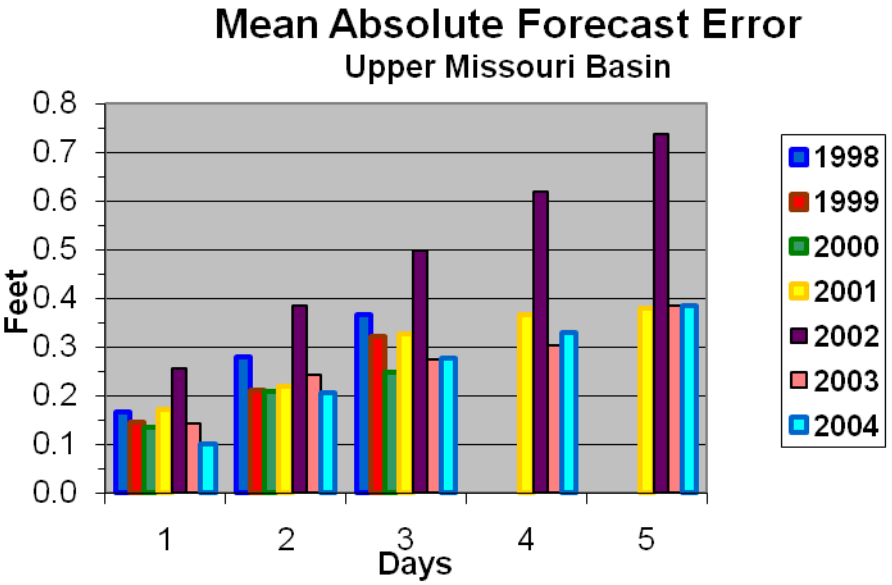
- stats were looked at by station, by forecast group, and all 6 stations combined

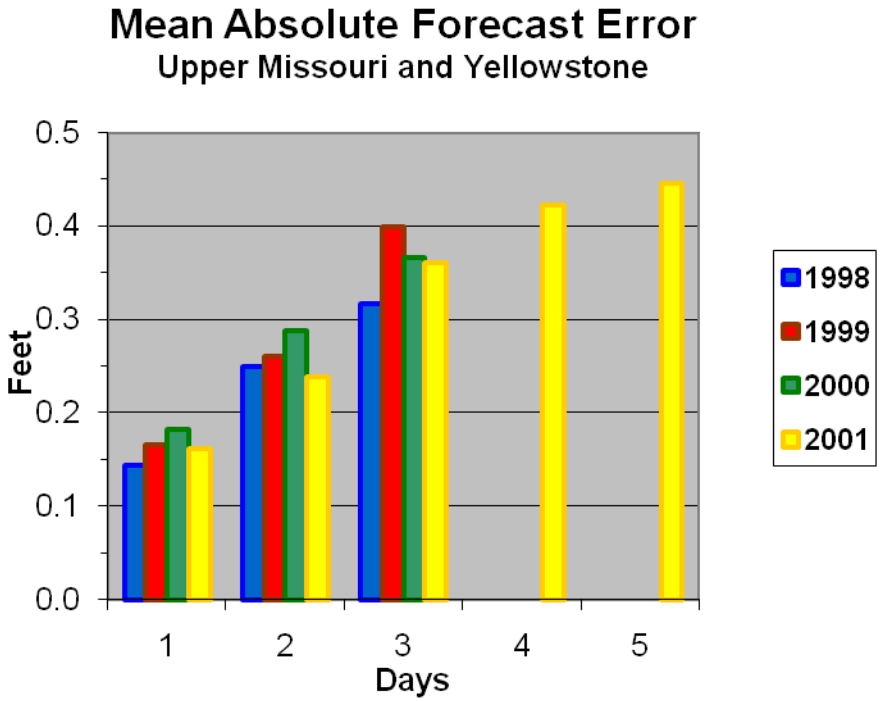
- also attempted a comparison to persistence

- some additional data was added in 2004

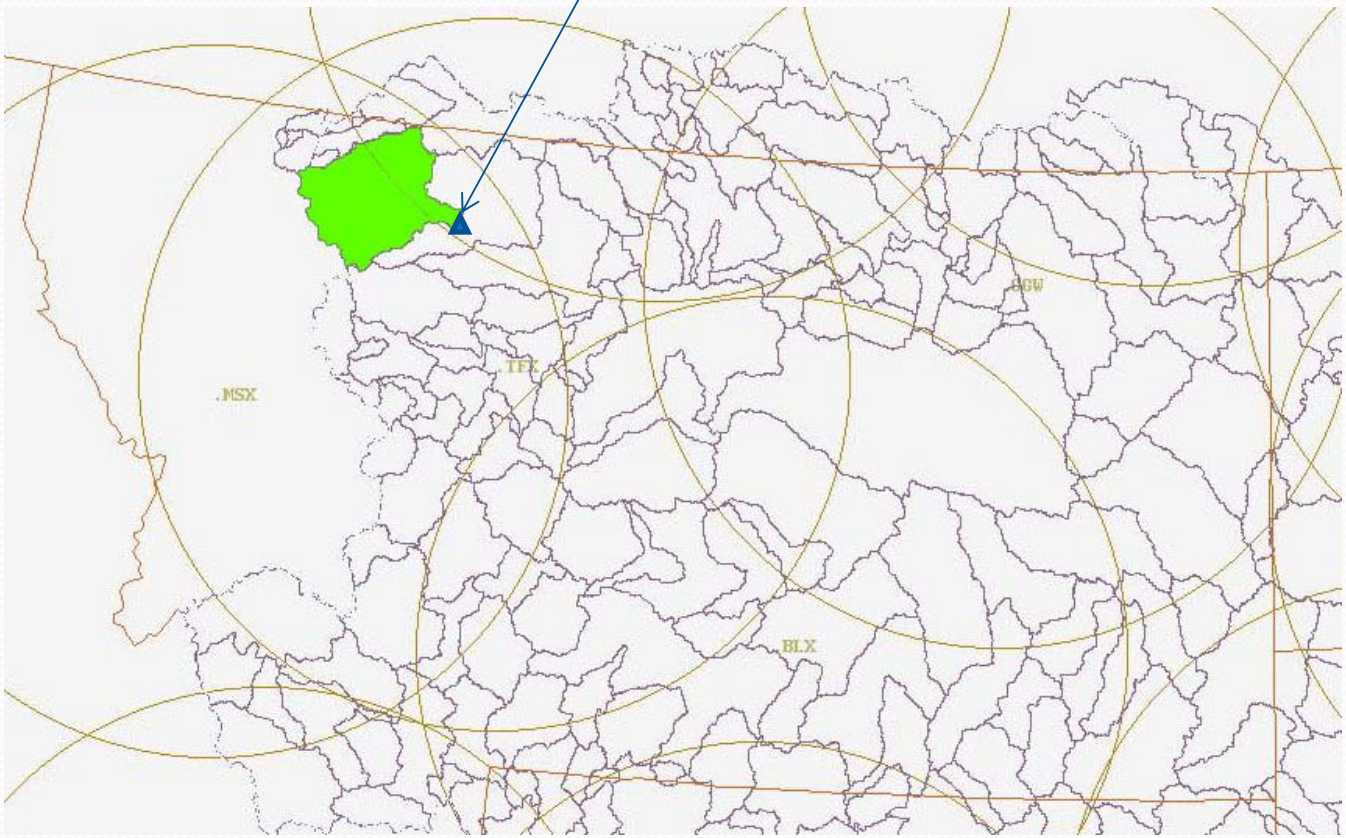


Examples from the earlier analysis





SHLM8
Marias River near Shelby, MT



Shelby gage site … looking north along I-15
05/26/2008 stage ~10.8 ft

Toole County, Montana
Hydrologic Unit Code 10030203
Latitude 48°25'38",
Longitude 111°53'20" NAD27
Drainage area 3,242 square miles
Gage datum
3,087.72 feet above sea level NGVD29

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1996	May 24, 1996	7.50[2]	6,480
1997	Mar. 20, 1997	9.02[2]	9,800
1998	Jul. 04, 1998	6.58	4,160
1999	May 26, 1999	6.26	3,620
2000	May 24, 2000	5.15	2,190
2001	May 15, 2001	5.54	2,800
2002	Jun. 11, 2002	12.30	20,700
2003	Mar. 15, 2003	6.85	4,180
2004	Jun. 08, 2004	5.15	1,840
2005	Jun. 06, 2005	7.14	5,160
2006	Jun. 14, 2006	6.52	4,050
2007	Nov. 10, 2006	5.41	2,380
2008	May 27, 2008	10.91	15,400E

SHLM8 – Marias River near Shelby, Mt

Some regulation by Lower Two Medicine Lake, Four Horns Res, Swift Res and Lake Frances. Diversions for irrigation of about 50,000 acres upstream and 15,000 acres downstream of station. Estimate of noncontributing area: 518 sq.mi.

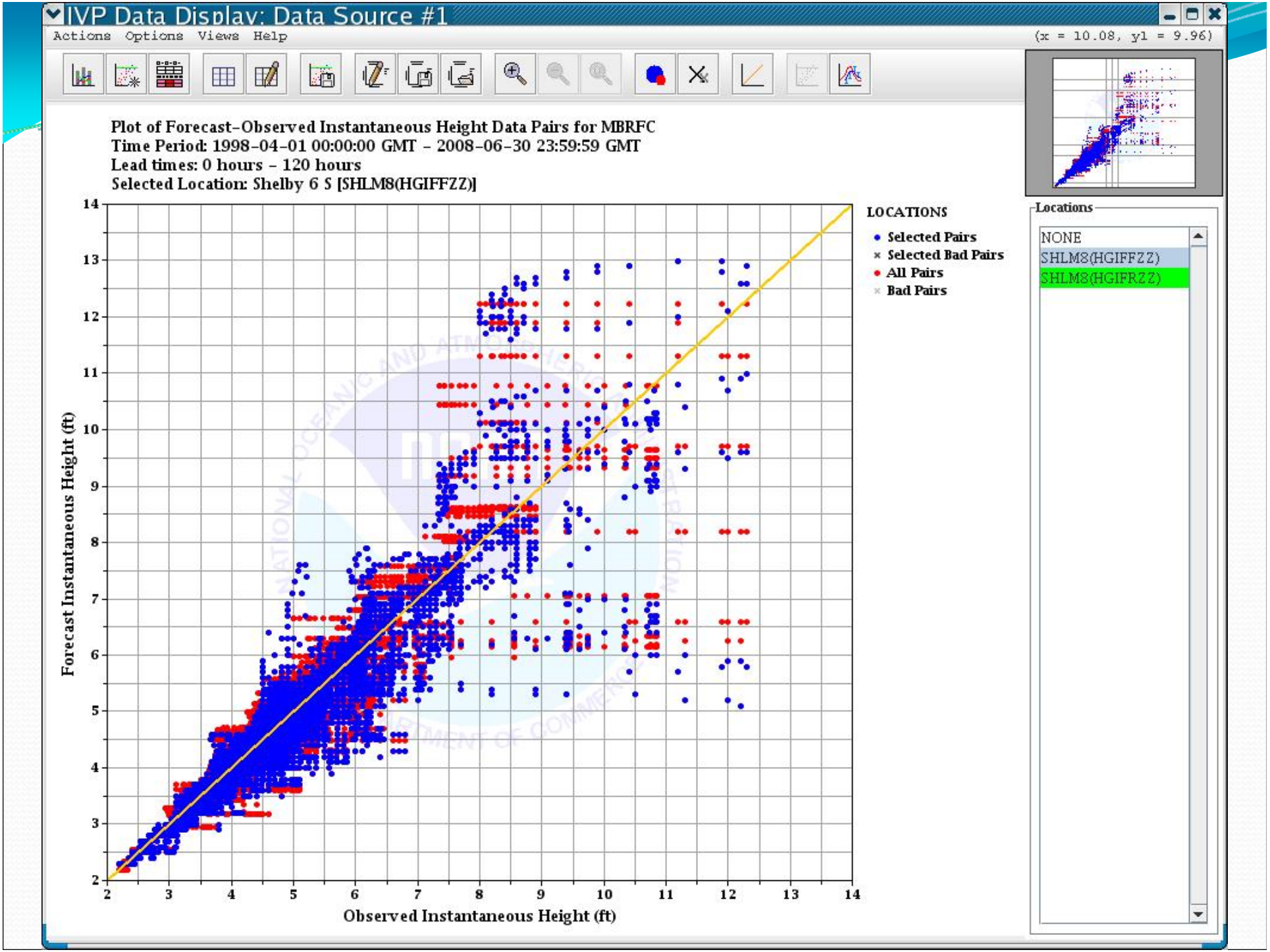
Currently the basin is modeled with two elevation zones, these are:

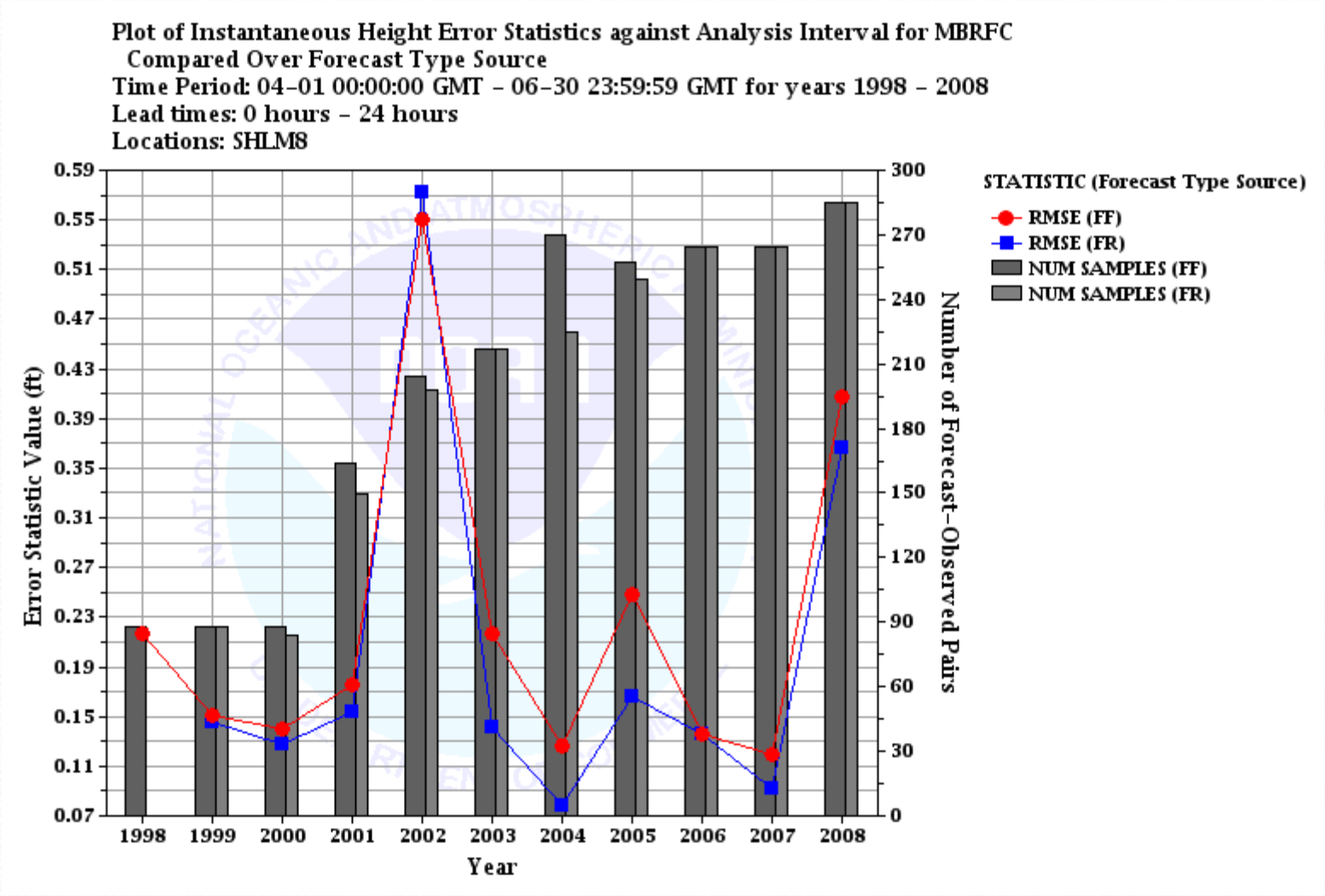
SHLM8UPR – abv 6500 ft to 8832 ft MSL
(upper zone is 5.8% of drainage area)

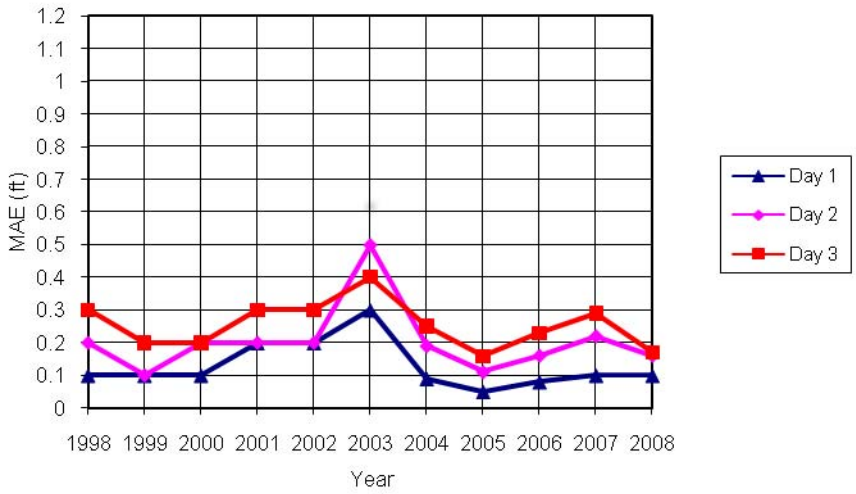
SHLM8LWR – ~3087 ft to 6500 ft MSL

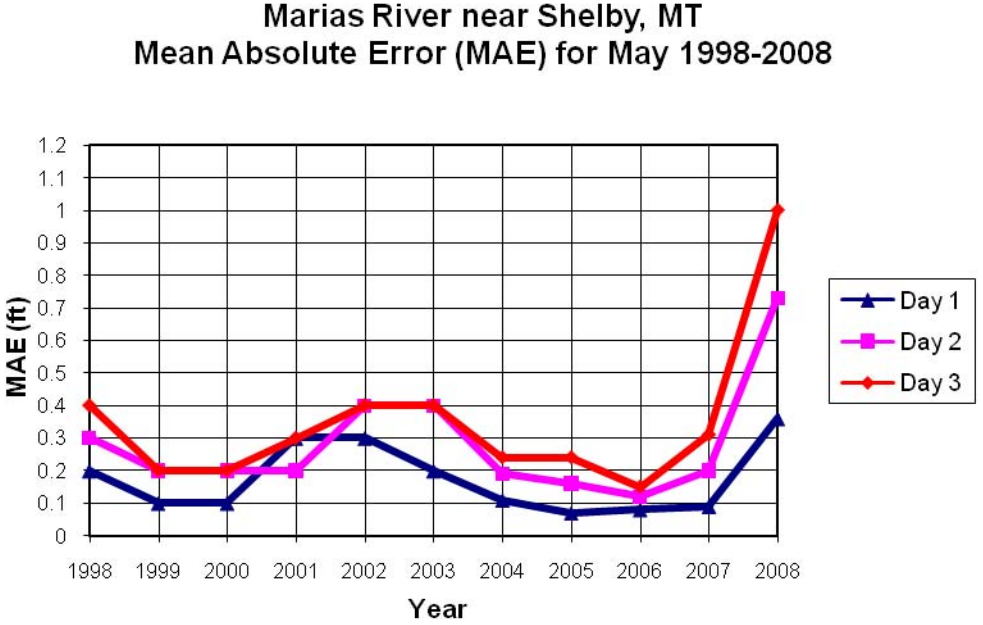
Flood Stage 9.0 ft

Record : June 20, 1975 18.21 ft 75,700 cfs
w/Swift Dam failure: June 9,1964 23.64 ft 241,000 cfs


IVP Data Display: Data Source #1
Actions Options Views Help
(x = 10.08, y1 = 9.96)
Plot of Forecast-Observed Instantaneous Height Data Pairs for MBRFC
Time Period: 1998-04-01 00:00:00 GMT - 2008-06-30 23:59:59 GMT
Lead times: 0 hours - 120 hours
Selected Location: Shelby 6 S [SHLM8(HGIFFZZ)]
Forecast Instantaneous Height (ft)
Observed Instantaneous Height (ft)
2
3
4
5
6
7
8
9
10
11
12
13
14
LOCATIONS
Selected Pairs
Selected Bad Pairs
All Pairs
Bad Pairs
Locations
NONE
SHLM8(HGIFFZZ)
SHLM8(HGIFRZZ)


Plot of Instantaneous Height Error Statistics against Analysis Interval for MBRFC
Compared Over Forecast Type Source
Time Period: 04-01 00:00:00 GMT - 06-30 23:59:59 GMT for years 1998 - 2008
Lead times: 0 hours - 24 hours
Locations: SHLM8
Error Statistic Value (ft)
0.59
0.55
0.51
0.47
0.43
0.39
0.35
0.31
0.27
0.23
0.19
0.15
0.11
0.07
Number of Forecast-Observed Pairs
300
270
240
210
180
150
120
90
60
30
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year
STATISTIC (Forecast Type Source)
RMSE (FF)
RMSE (FR)
NUM SAMPLES (FF)
NUM SAMPLES (FR)


Marias River near Shelby, MT
Mean Absolute Error (MAE) for April 1998-2008
MAE (ft)
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
Year
Day 1
Day 2
Day 3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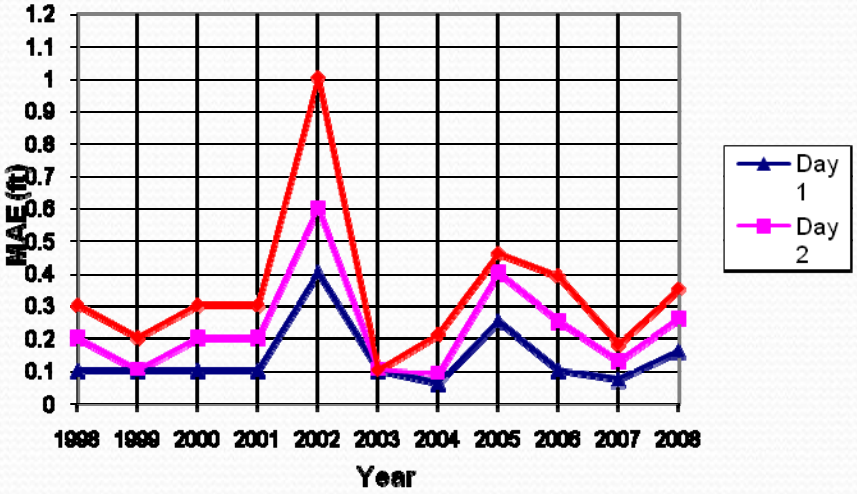
0.5
0.4
0.3
0.2
0.1
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
Year
Day 1
Day 2
Day 3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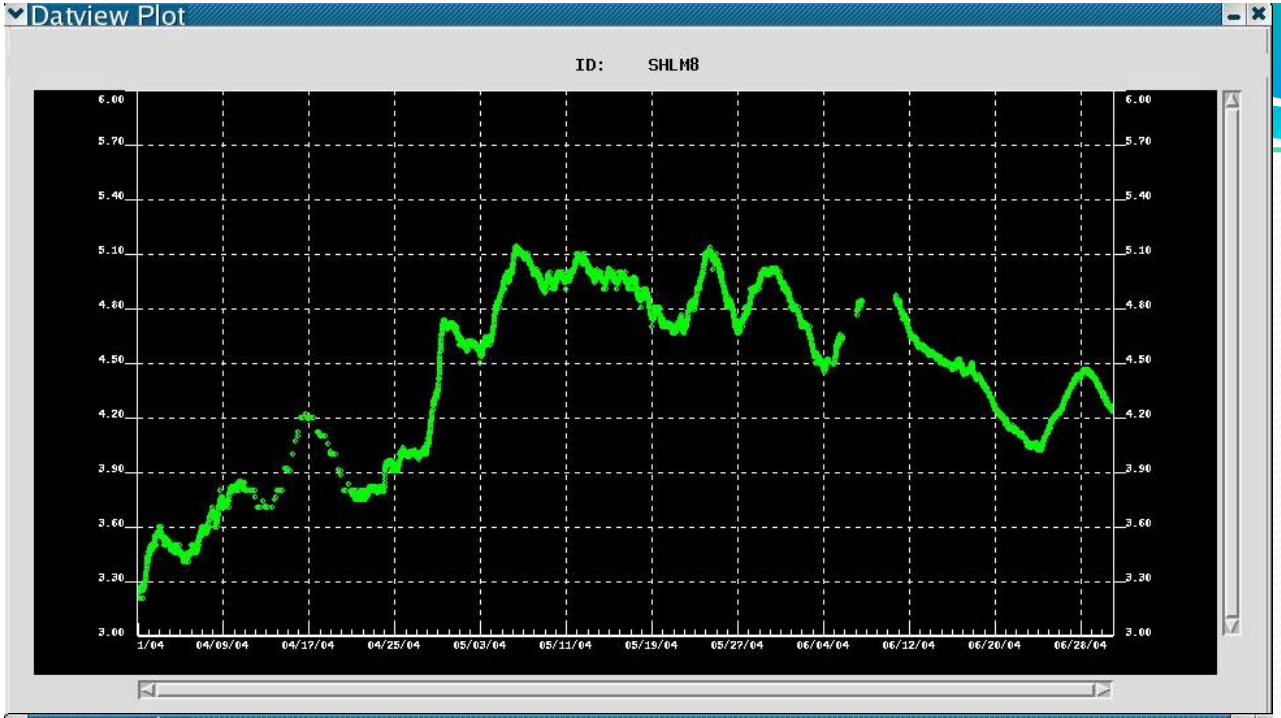
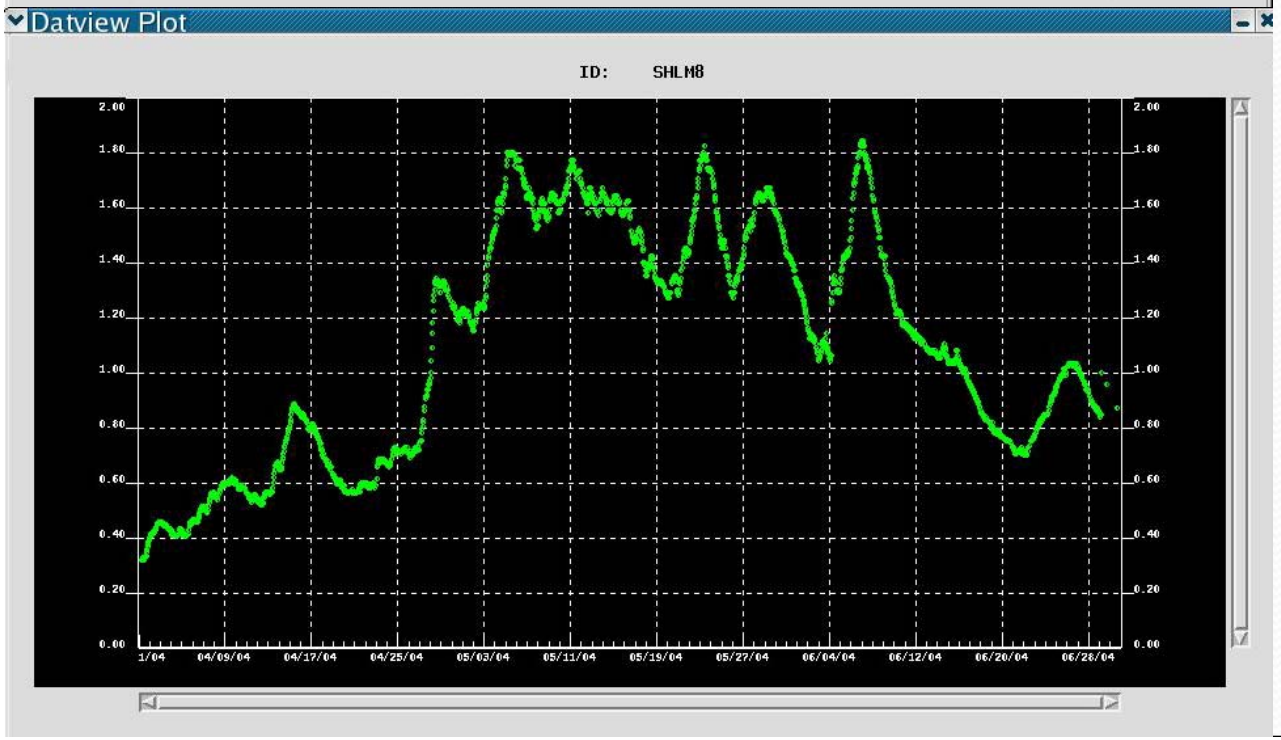
0.5
0.4
0.3
0.2
0.1
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
Year
Day 1
Day 2

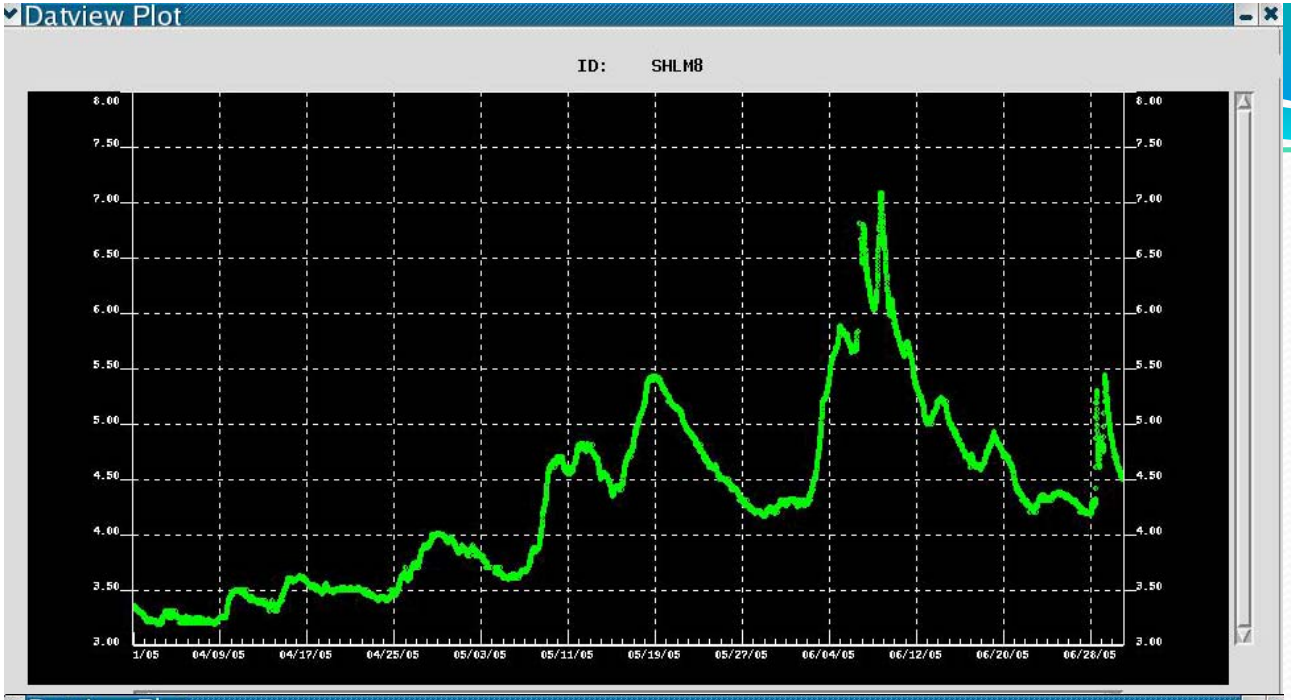


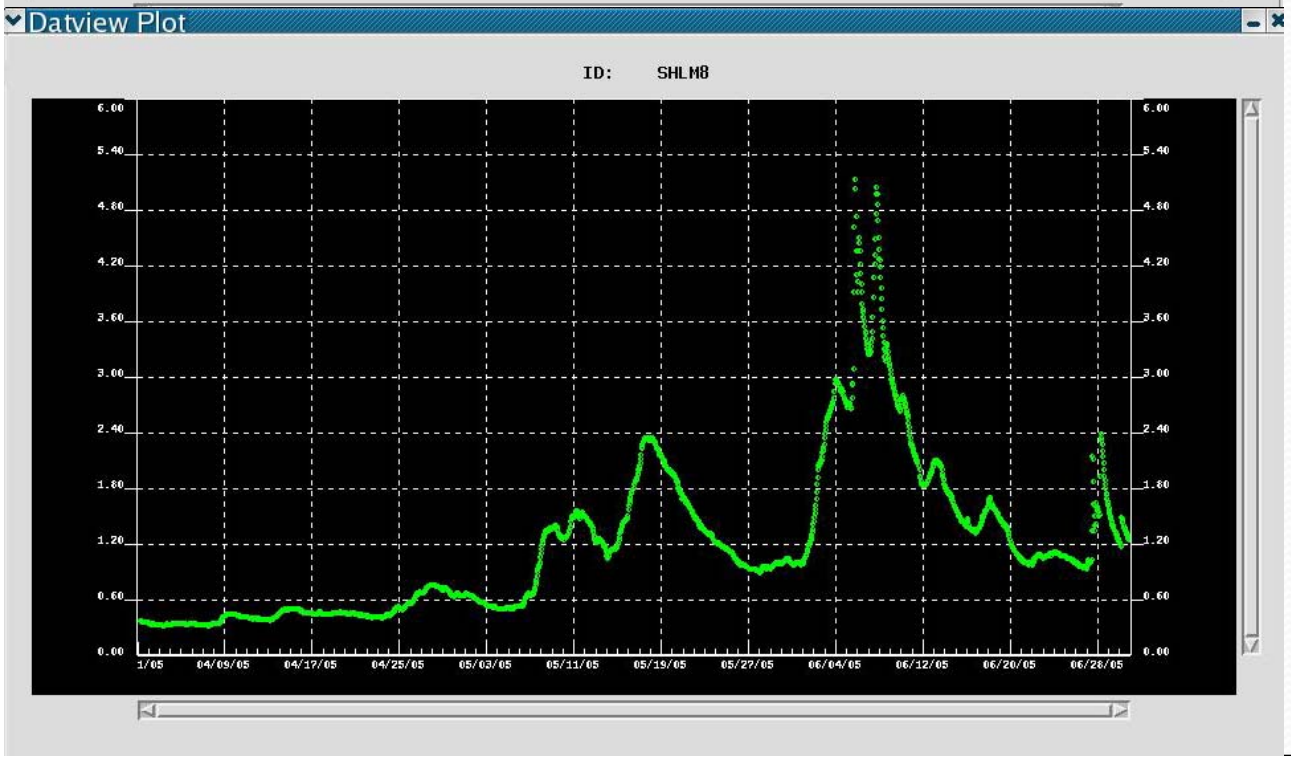


2004

Stages range from
3.1 ft to 5.2 ft

Flows range from
0.300 kcfs to 1.900 kcfs

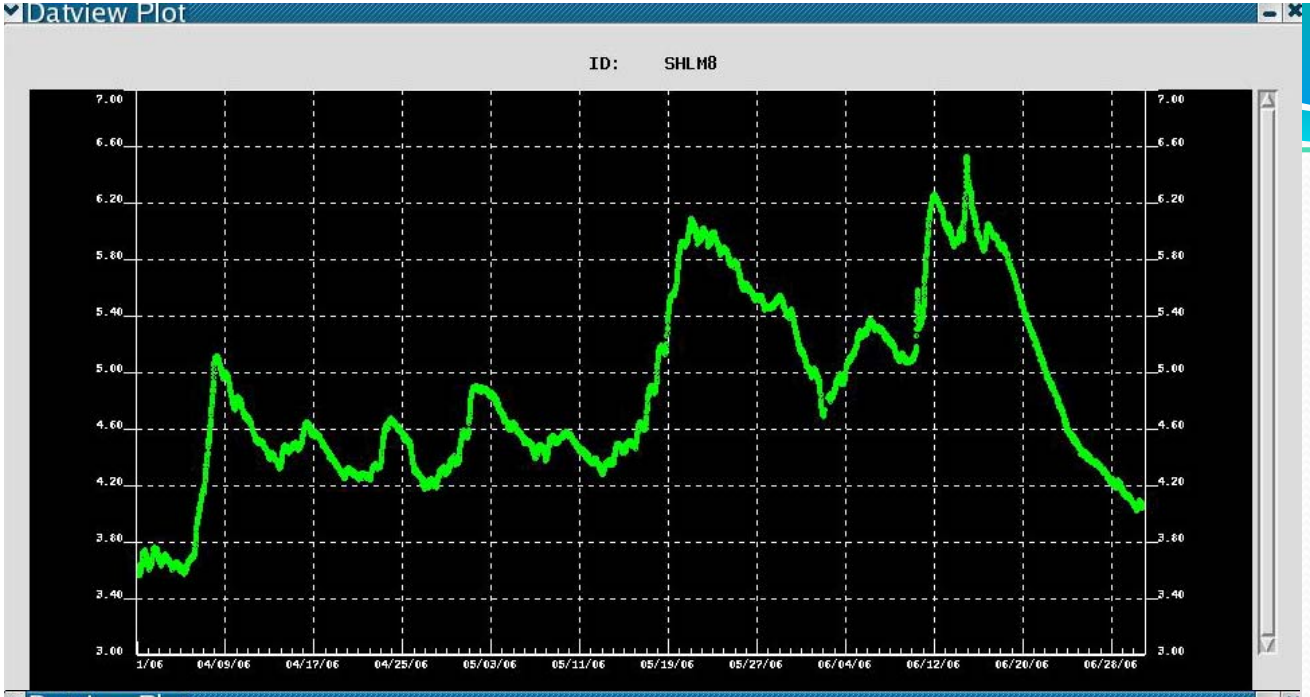


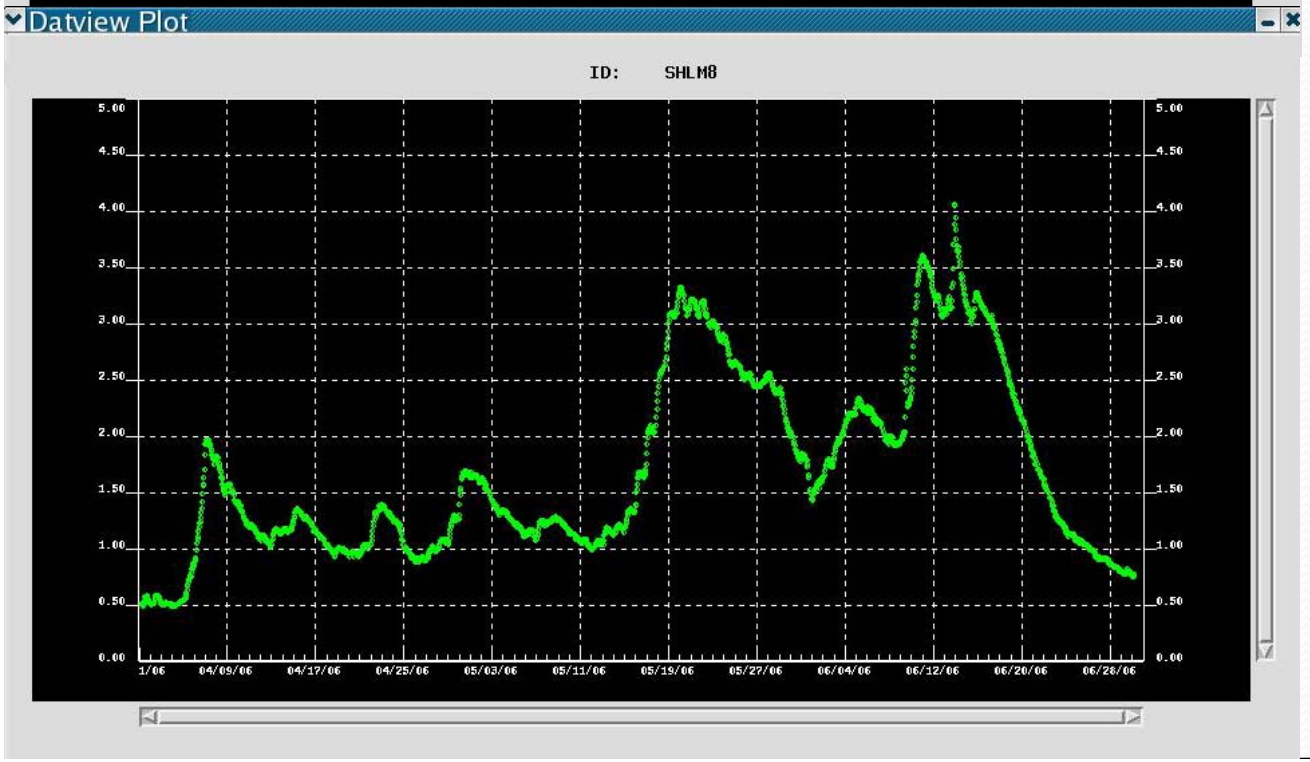


2005

Stages range from
3.1 ft to 7.2 ft

Flows range from
0.300 kcfs to 5.200 kcfs

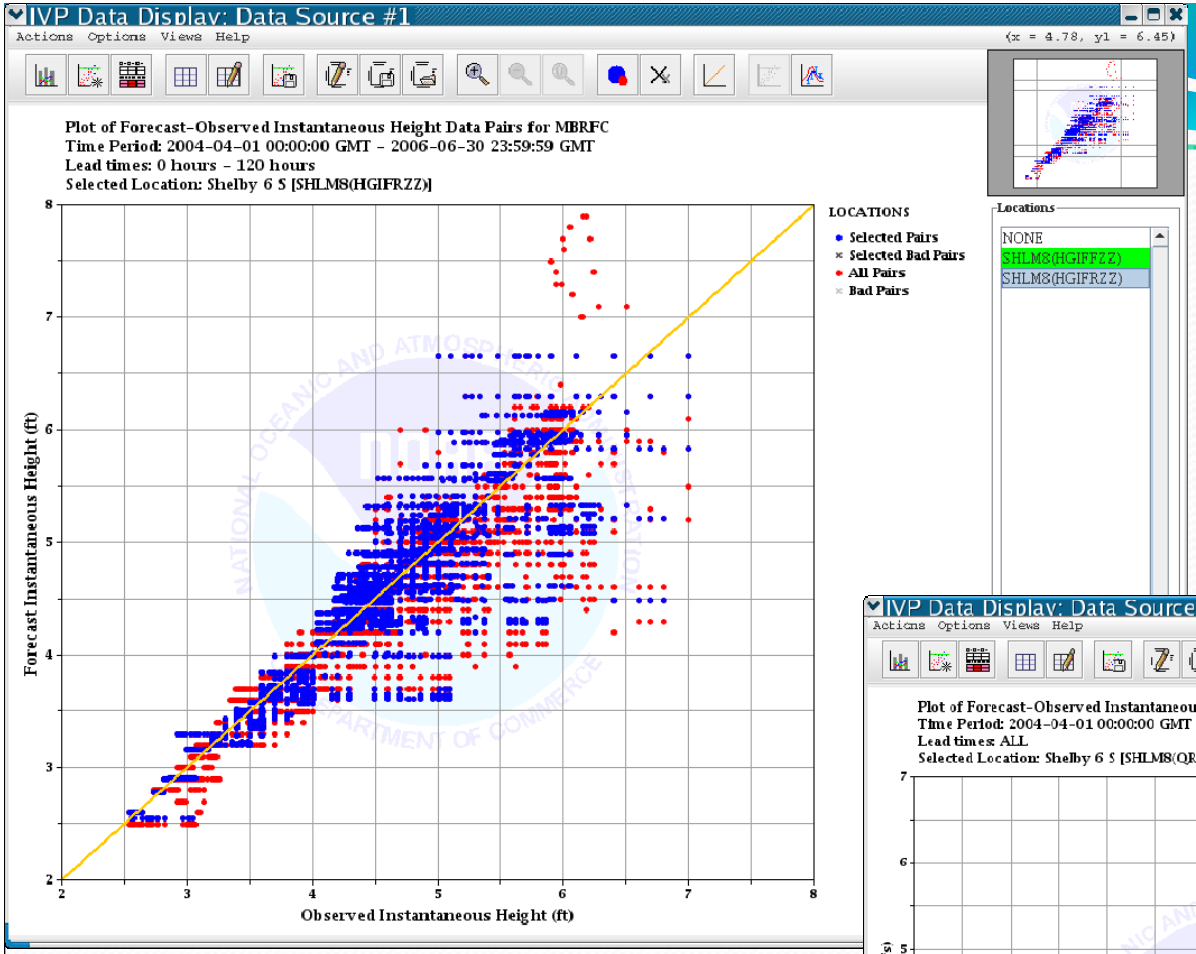




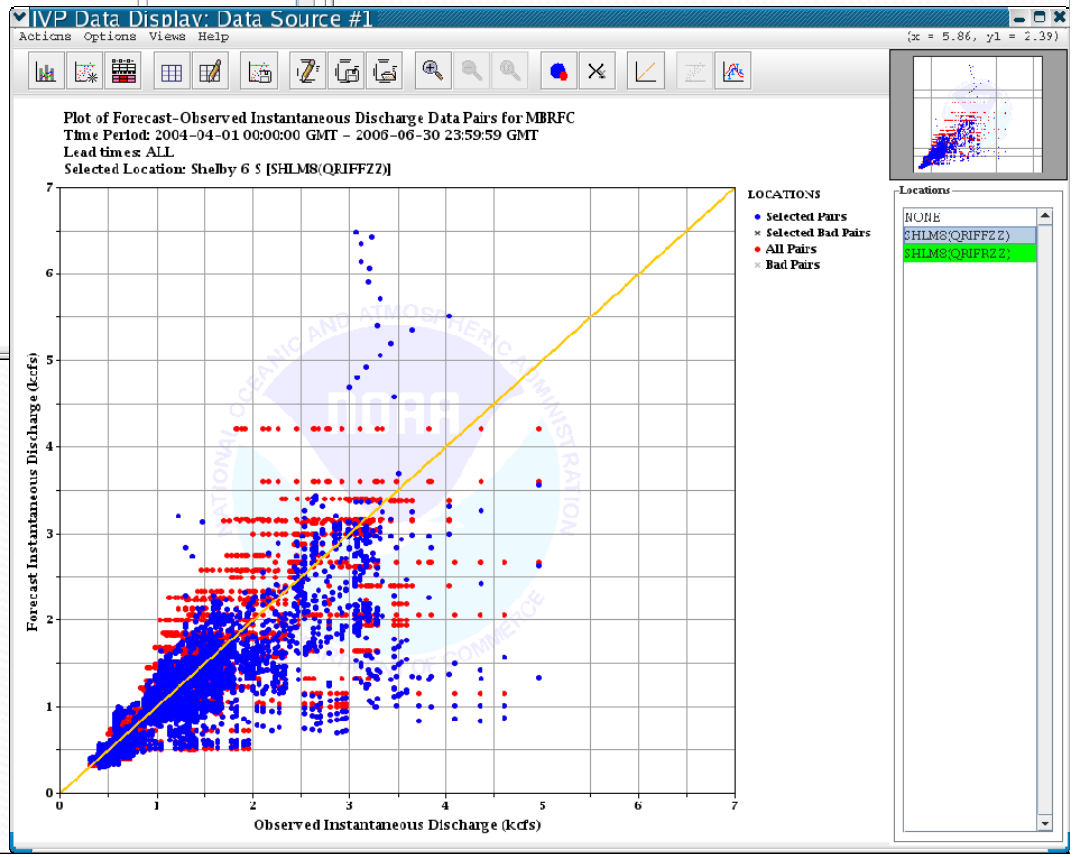
2006

Stages range from
3.5 ft to 6.6 ft

Flows range from
0.500 kcfs to 4.100 kcfs



←Stages 2004 – 2006
Blue = FF
Red = FR

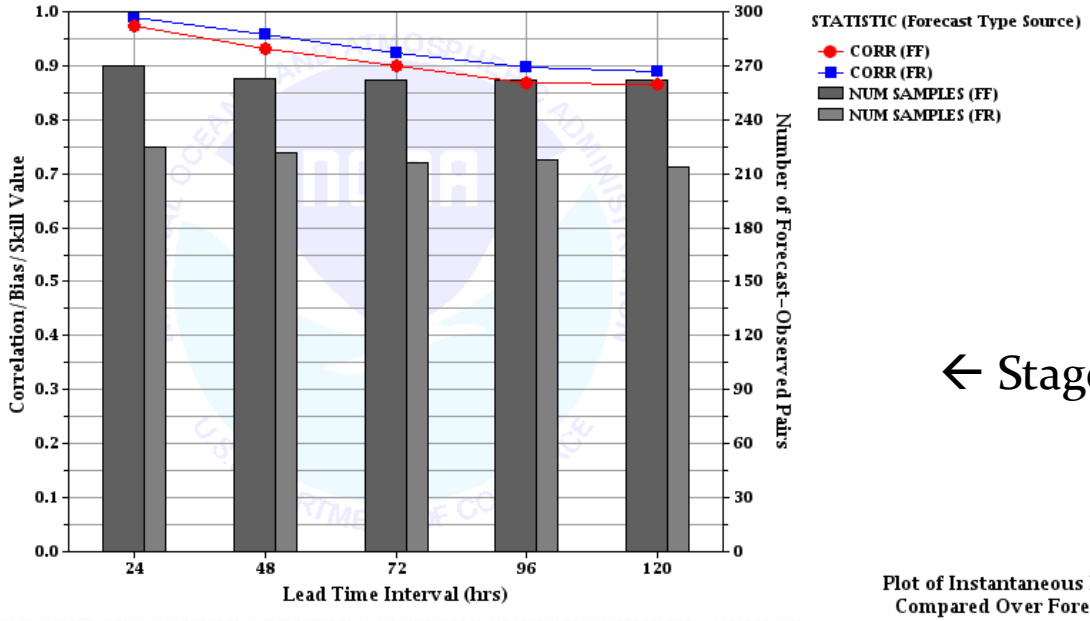


2004 – 2006 Flows →
Blue – FF
Red - FR

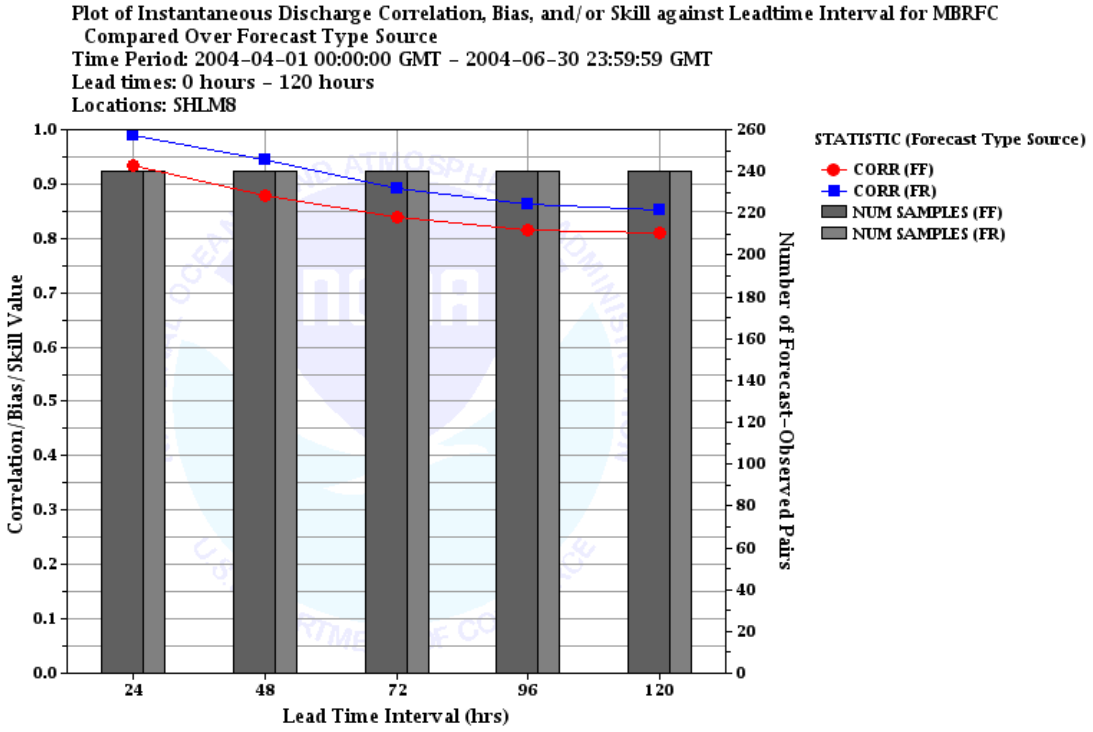
Pearson's Correlation

April – May 2004

← Stages



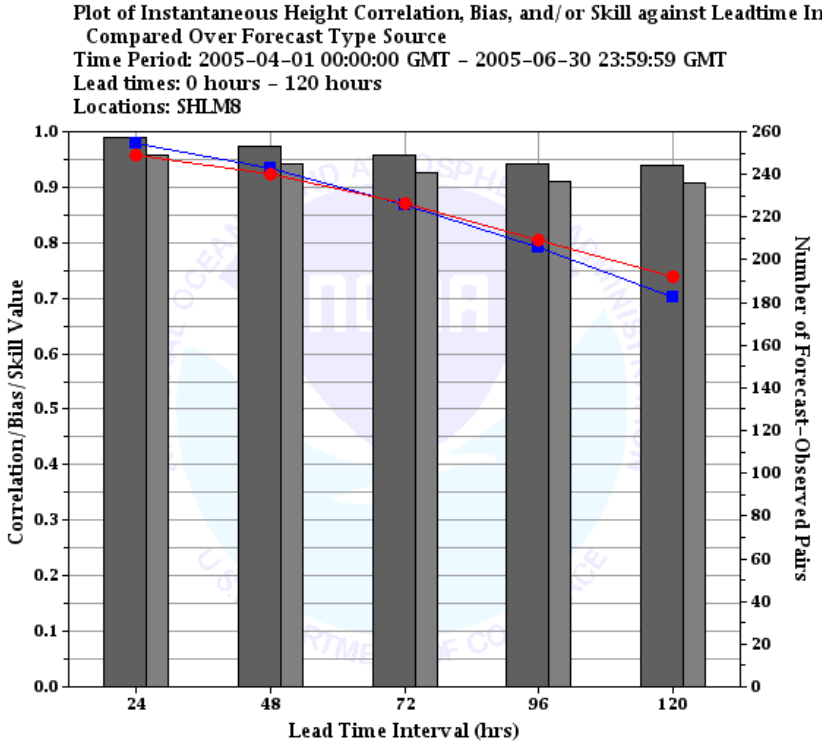
Flows →



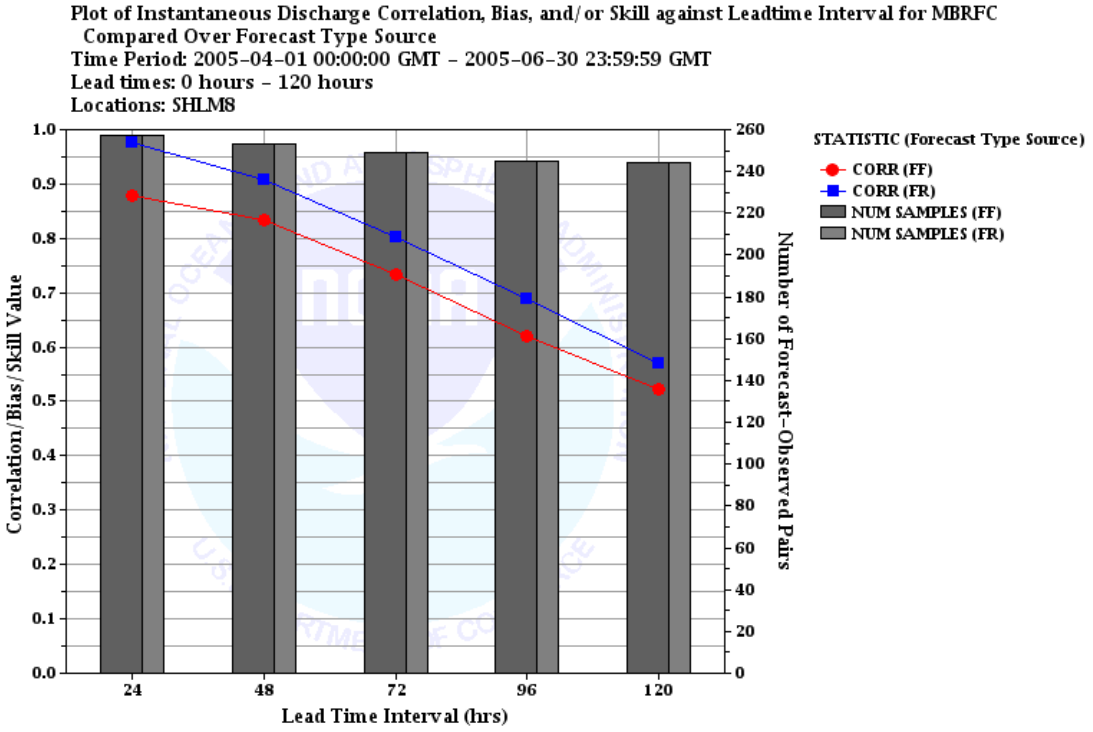
Pearson's Correlation

April – May 2005

← Stages



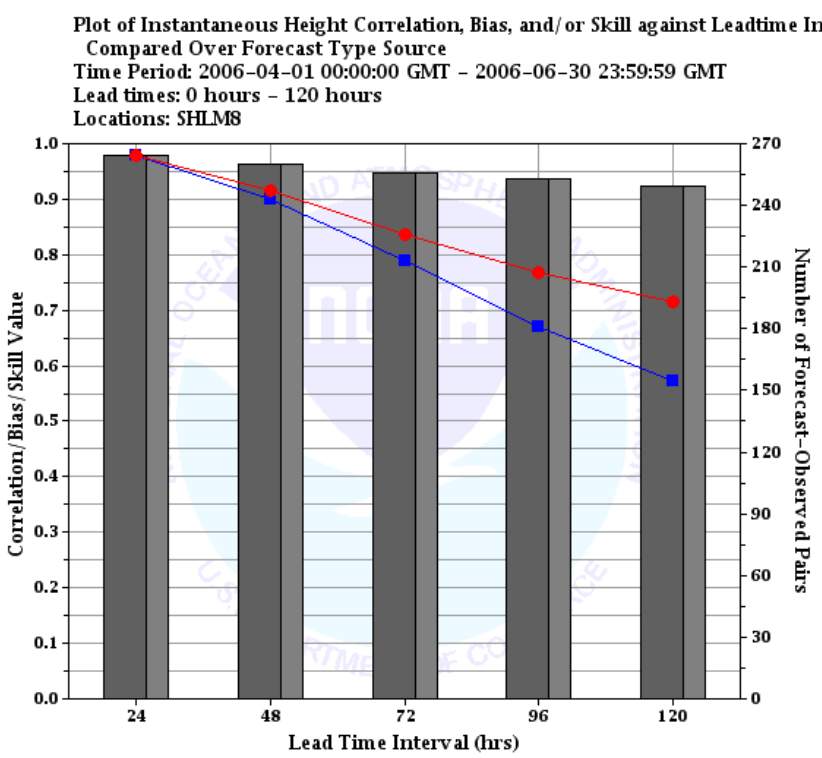
Flows →



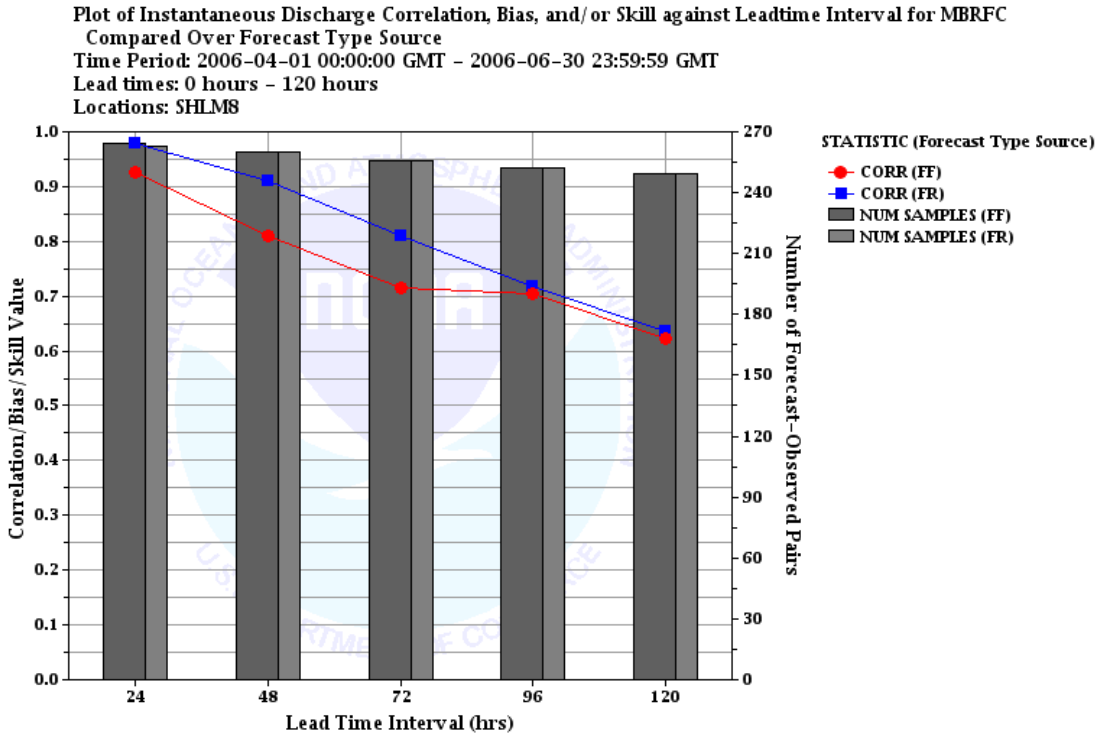
Pearson's Correlation

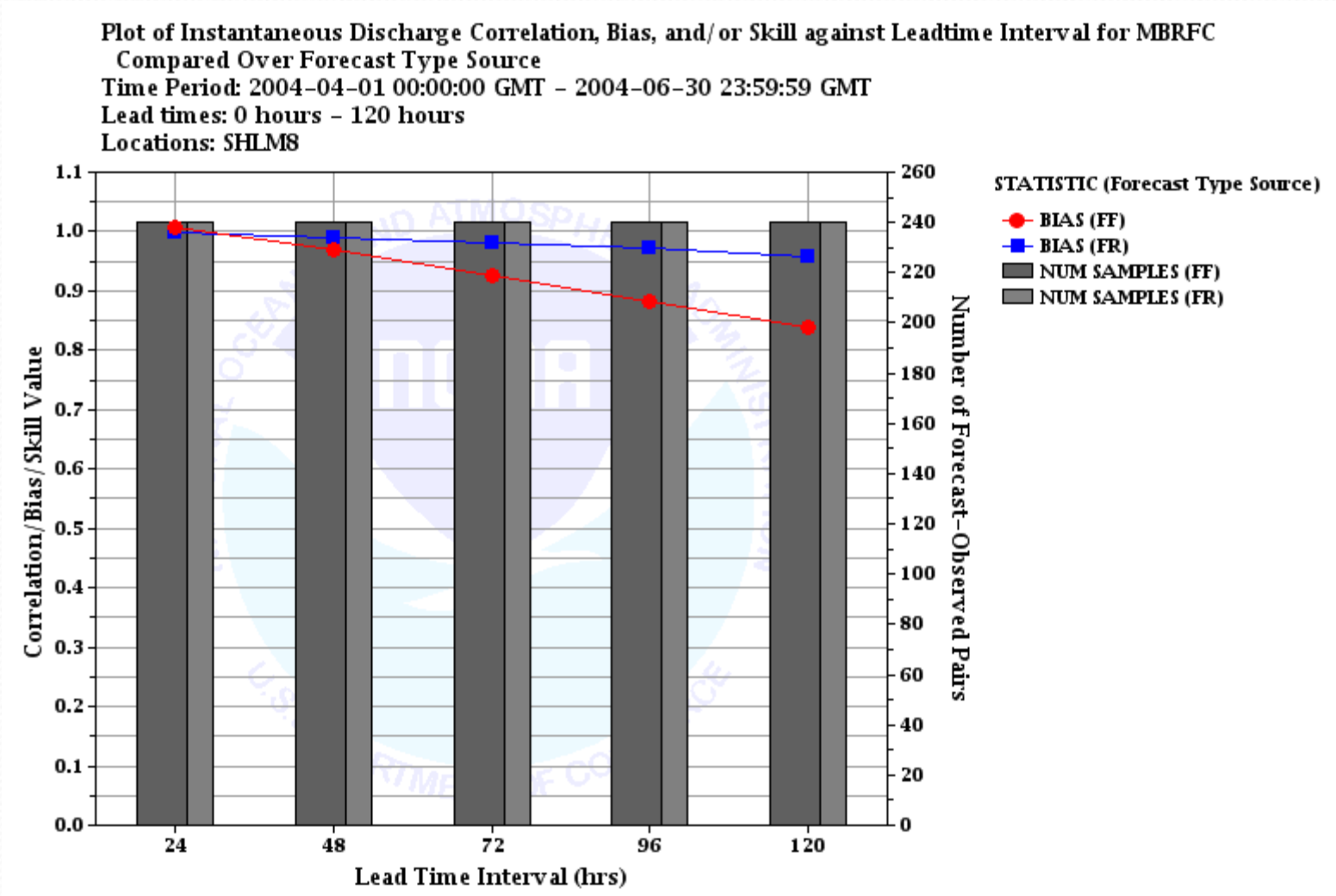
April – May 2006

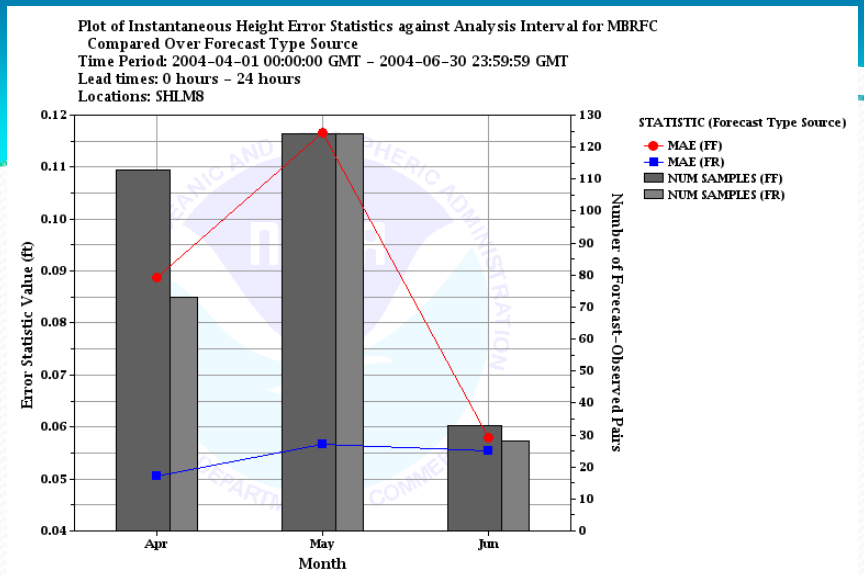
← Stages



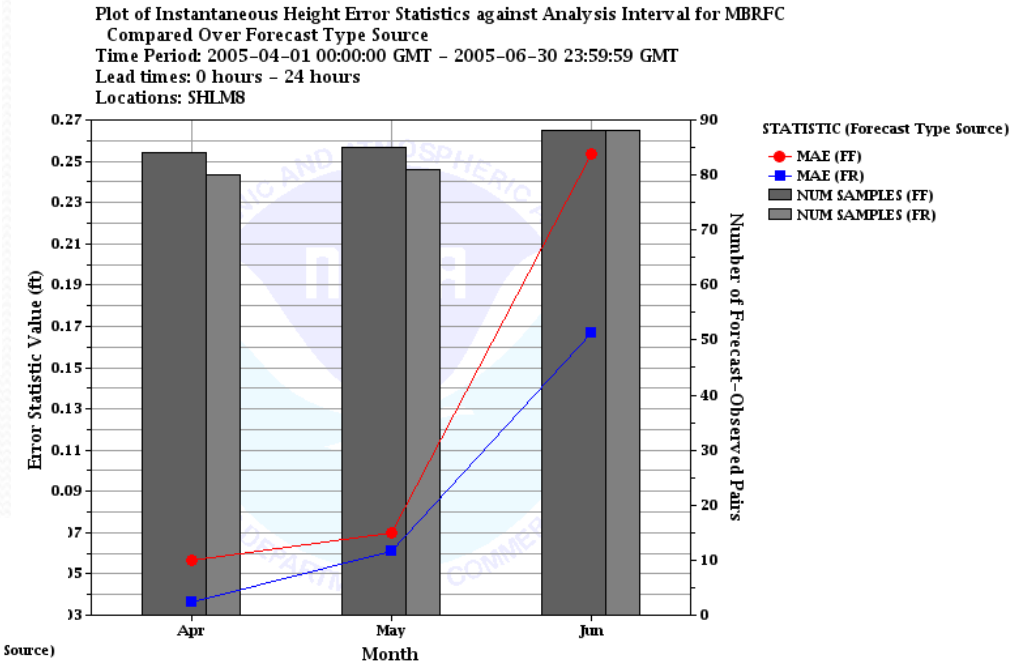
Flows →



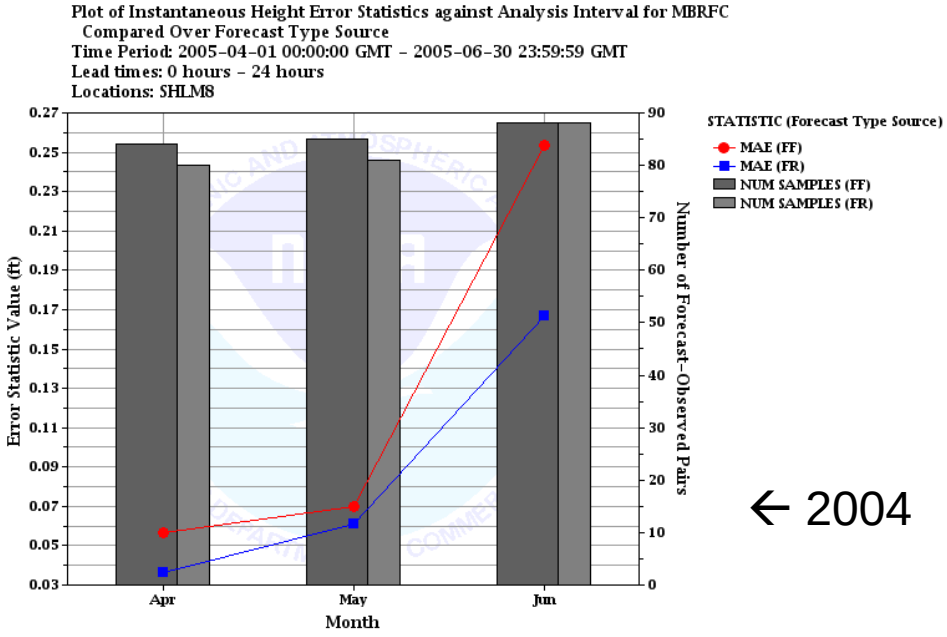

Plot of Instantaneous Discharge Correlation, Bias, and/or Skill against Leadtime Interval for MBRFC
Compared Over Forecast Type Source
Time Period: 2004-04-01 00:00:00 GMT - 2004-06-30 23:59:59 GMT
Lead times: 0 hours - 120 hours
Locations: SHLM8
Correlation/Bias/Skill Value
Number of Forecast-Observed Pairs
Lead Time Interval (hrs)
24
48
72
96
120
STATISTIC (Forecast Type Source)
BIAS (FF)
BIAS (FR)
NUM SAMPLES (FF)
NUM SAMPLES (FR)



← 2004



2005 →

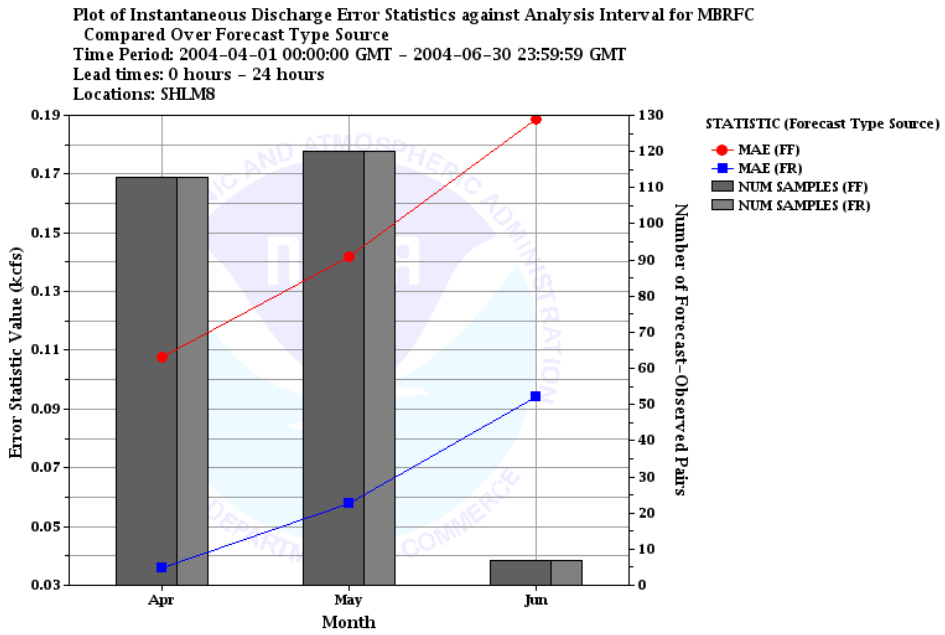


← 2004

Mean Absolute Error (MAE)

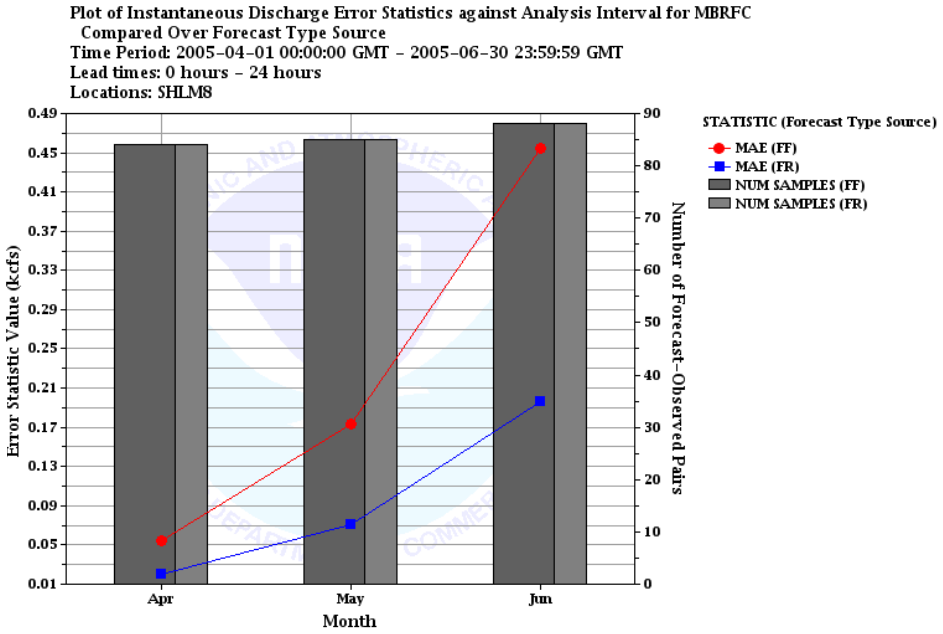
Stages

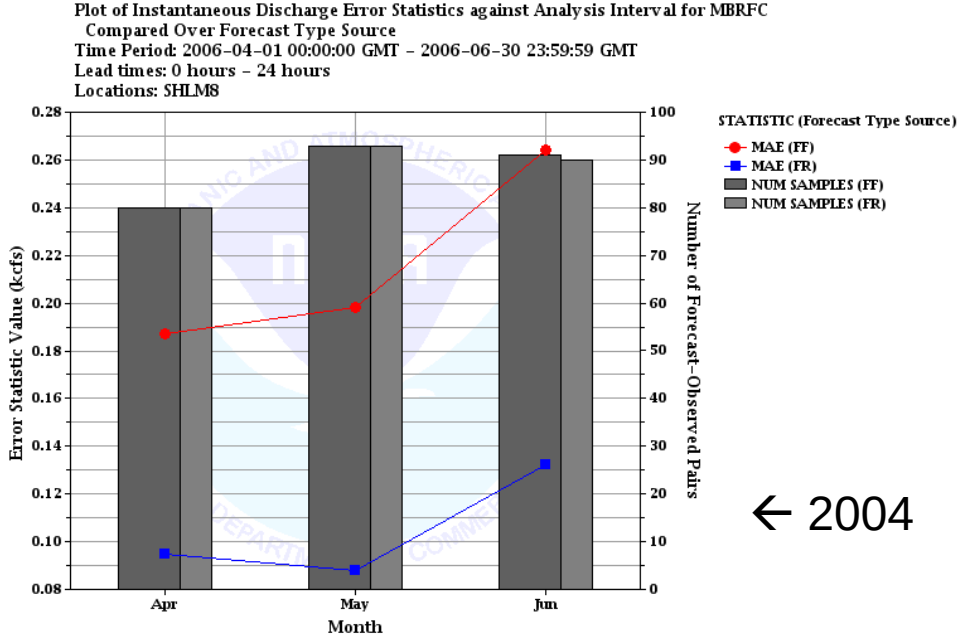
Red = FF Blue = FR



← 2004

2005 →



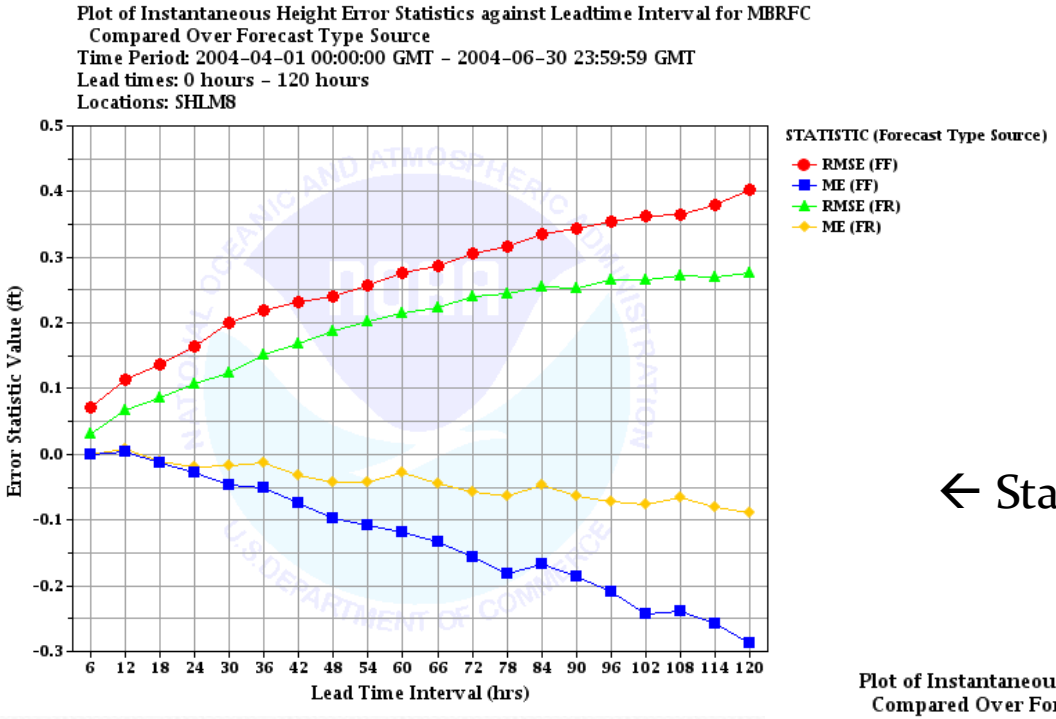


← 2004

Mean Absolute Error (MAE)

Flows

Red = FF Blue = FR



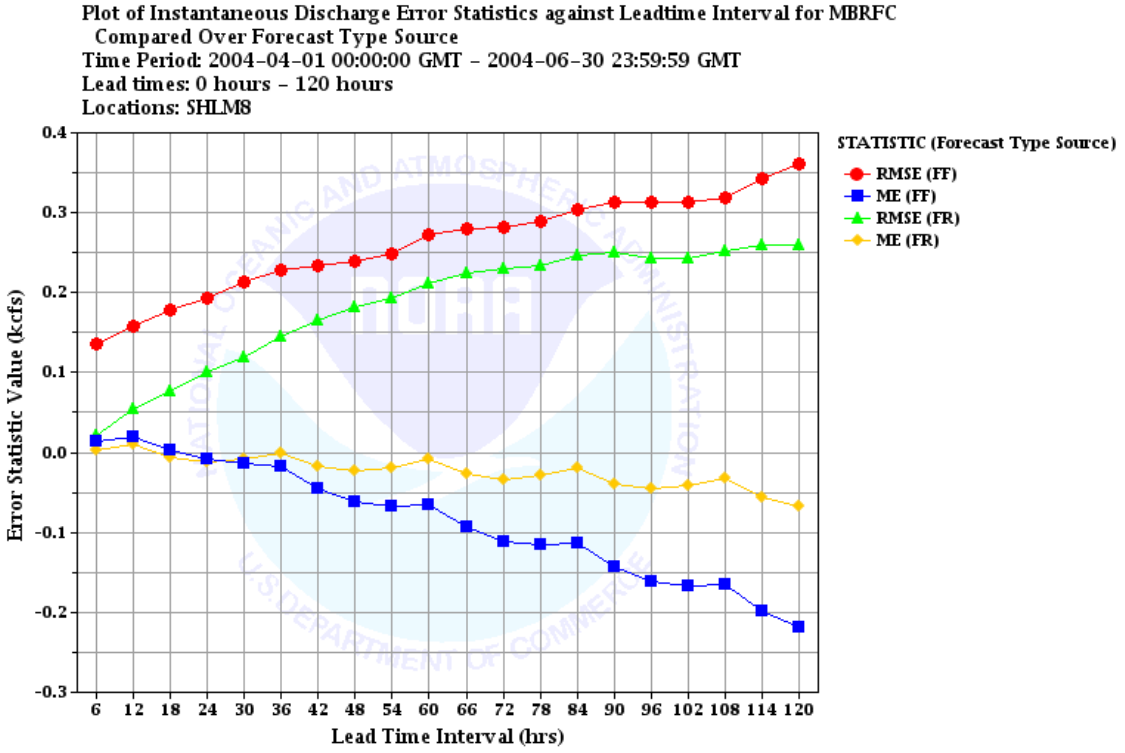
Root Mean Squared Error (RMSE) and Mean Error (ME)

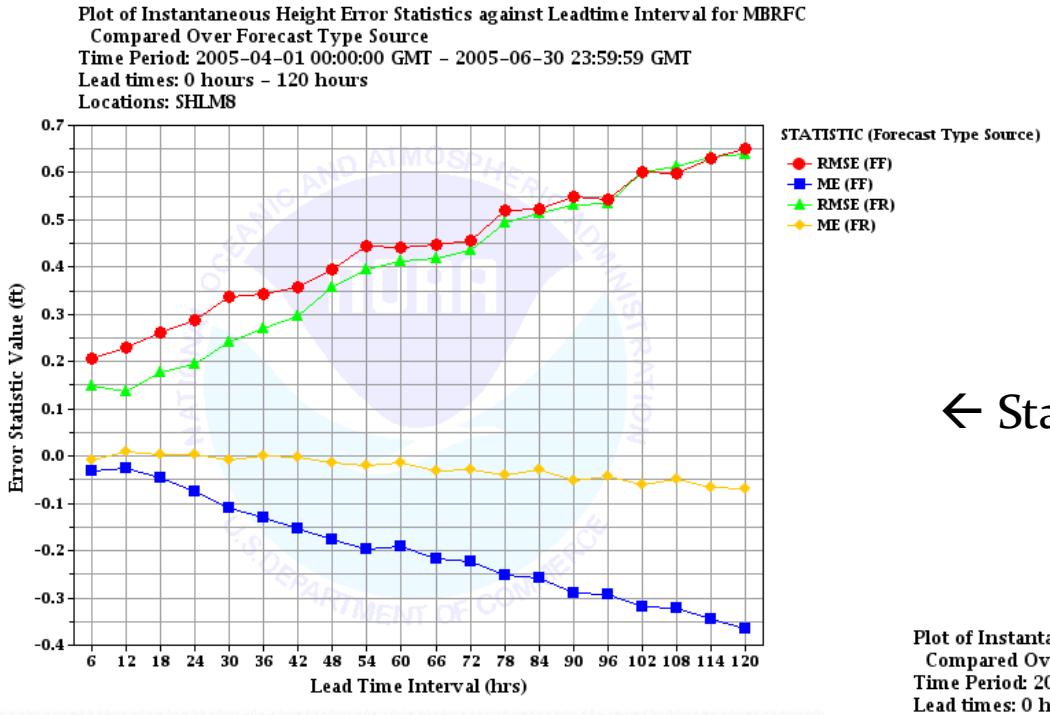
red & blue = FF
green & yellow = FR

← Stages

Flows →

April-May 2004





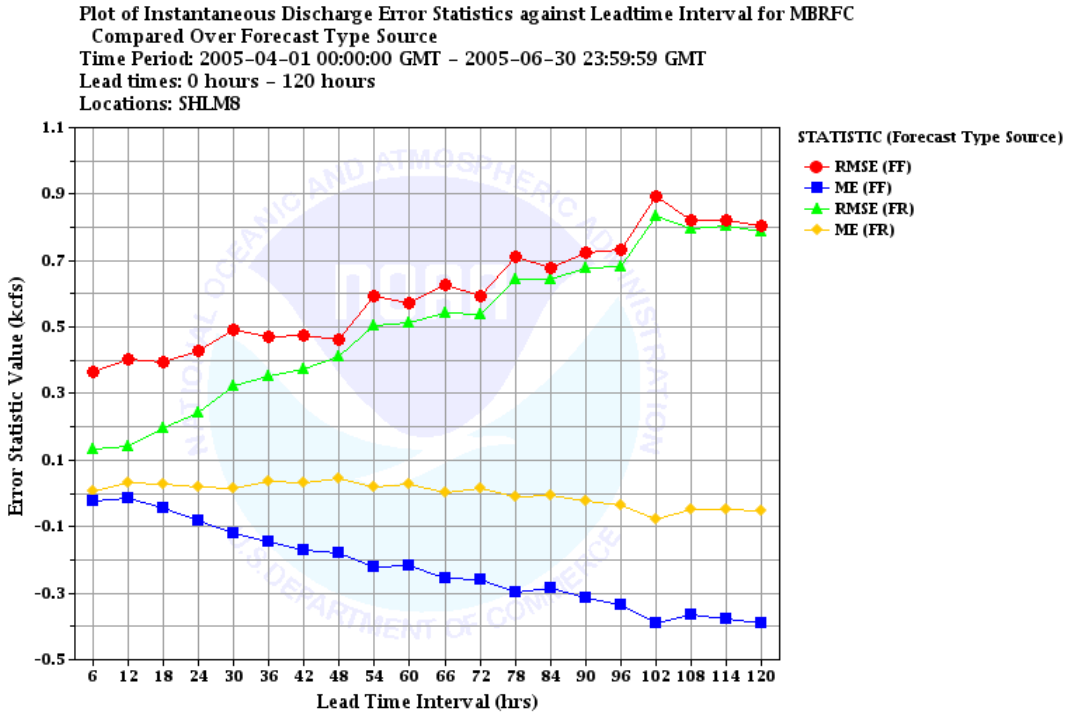
Root Mean Squared Error (RMSE) and Mean Error (ME)

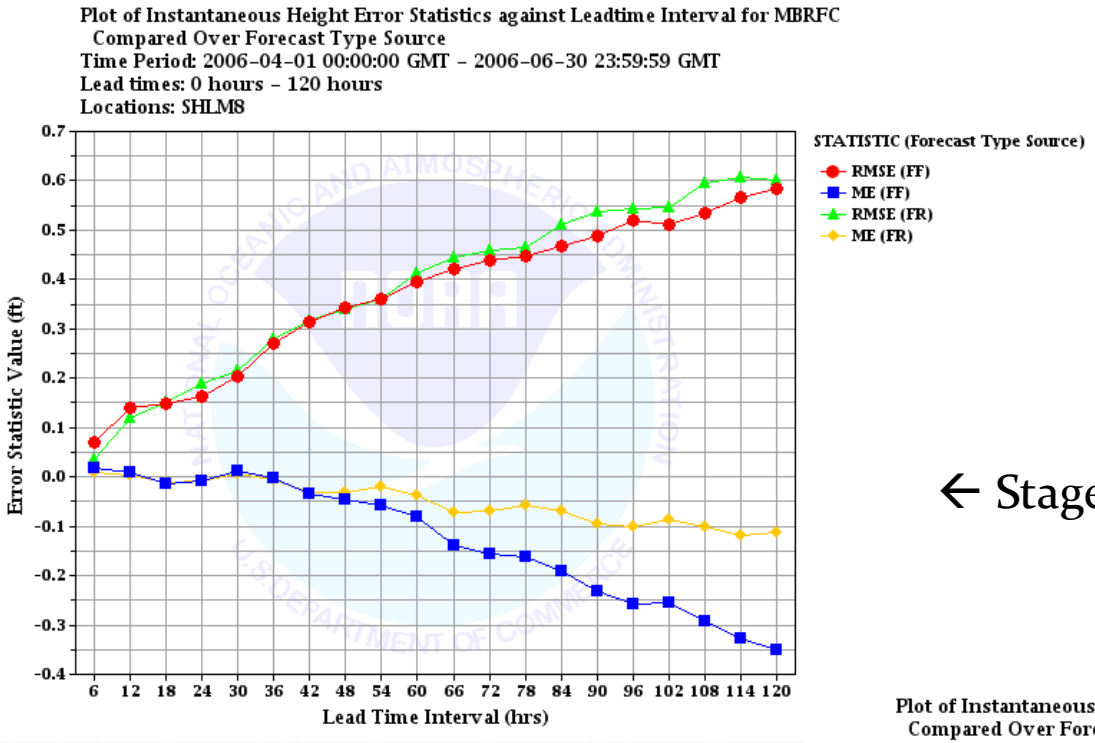
red & blue = FF
green & yellow = FR

← Stages

Flows →

April-May 2005





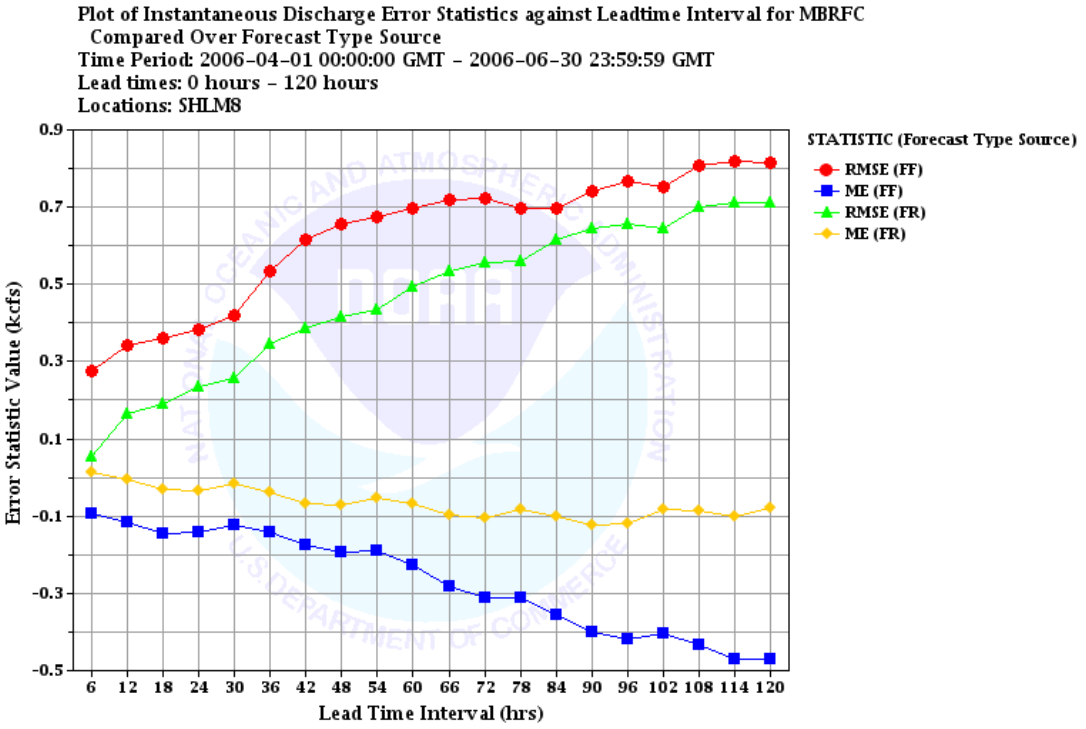
Root Mean Squared Error (RMSE) and Mean Error (ME)

red & blue = FF
green & yellow = FR

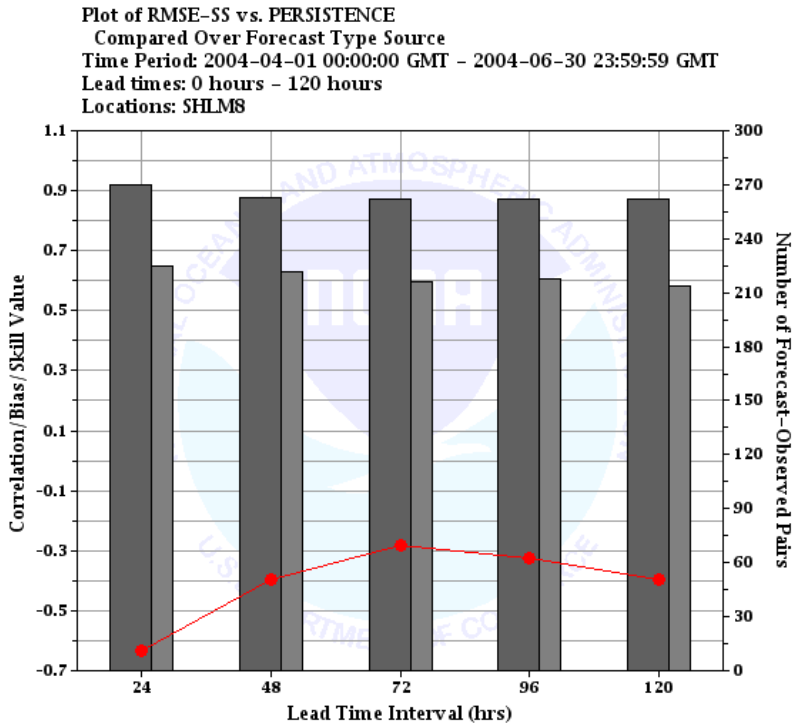
← Stages

Flows →

April-May 2006



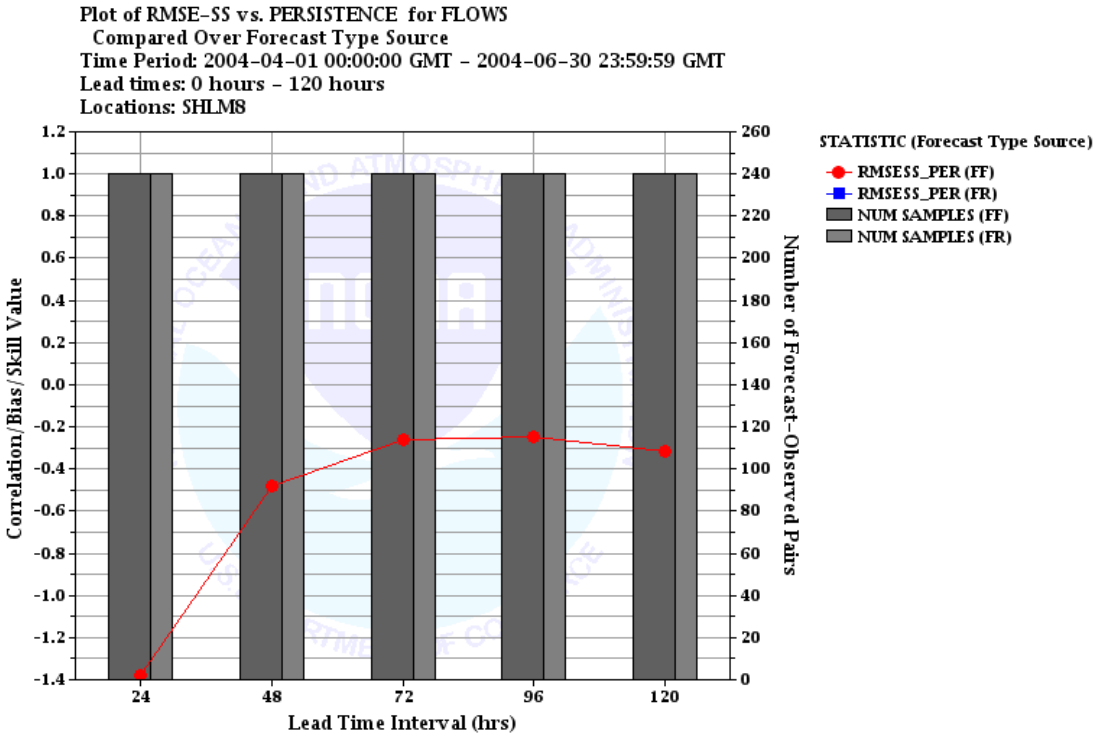
Root Mean Square Error Skill Score (RMSE-SS)



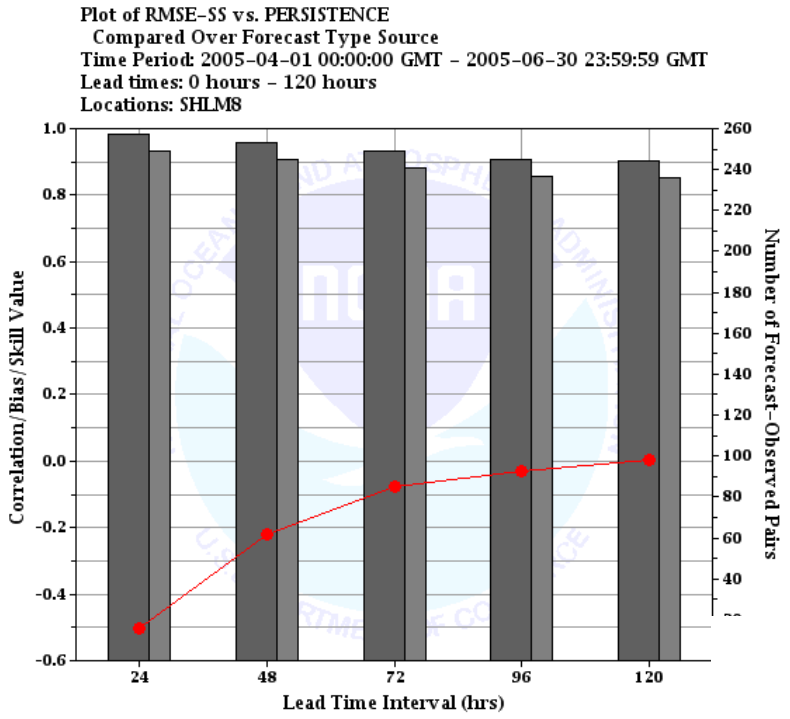
← Stages

Flows →

April-May 2004



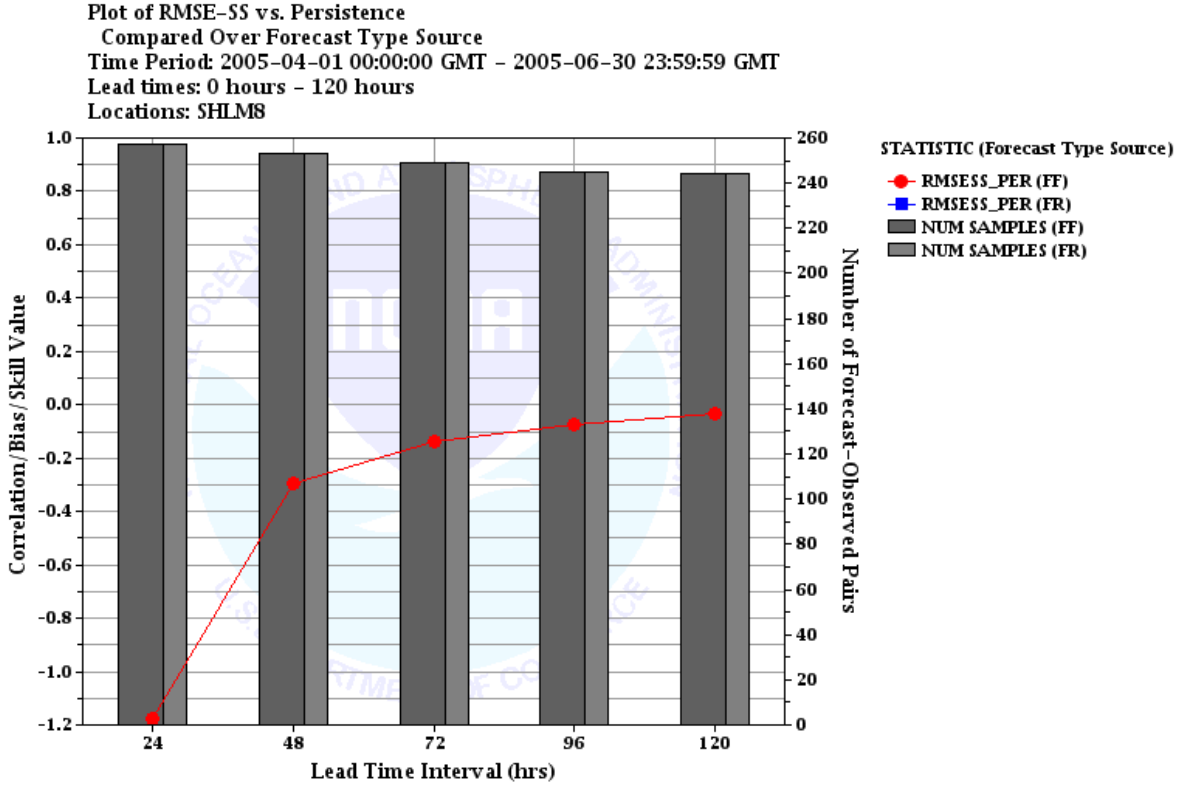
Root Mean Square Error
Skill Score (RMSE-SS)

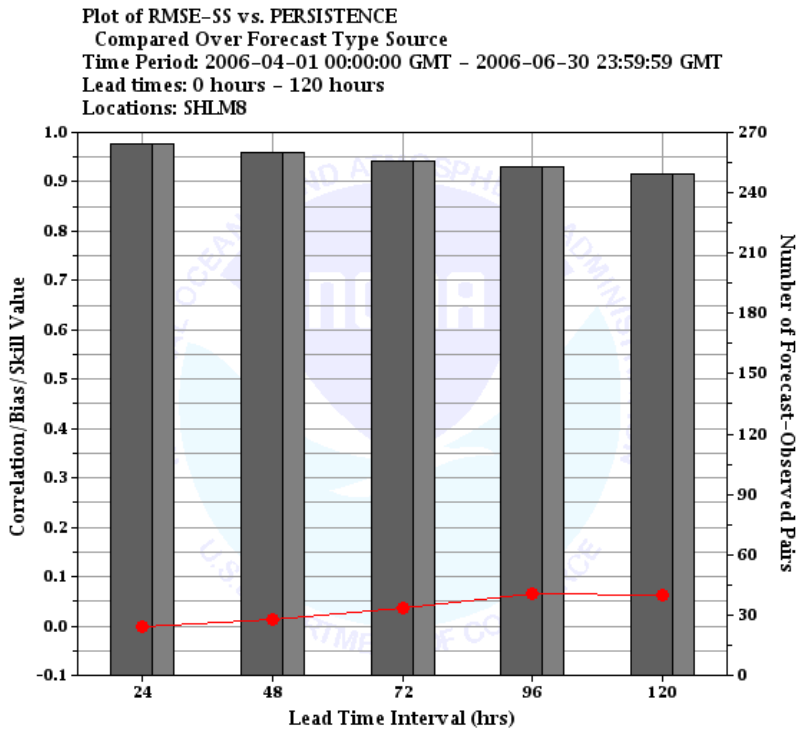


← Stages

Flows →

April-May 2005



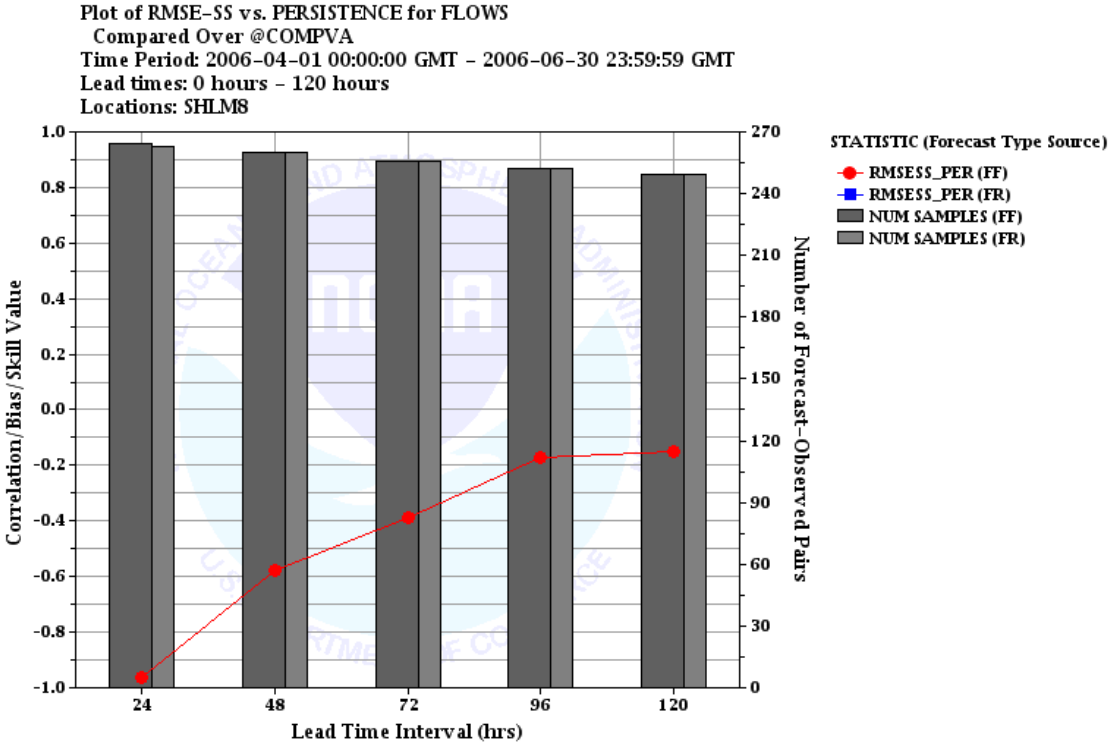


Root Mean Square Error Skill Score (RMSE-SS)

← Stages

Flows →

April-May 2006



In Conclusion

- Currently it appears that persistence is better than the RFC issued forecasts.

- This case study has given me more questions than answers, would like to look at more forecast points, in particular, ones that are further downstream.

- This case study re-enforces the need to break up this basin and take advantage of the USGS/USBR gages, break out the reservoirs and take into account off-stream storage and diversions.

- I've learned a lot about how to use IVP GUI to create plots but still have more to learn as this study did not look at categorical forecast measures.