

HMOS Verification Exercise

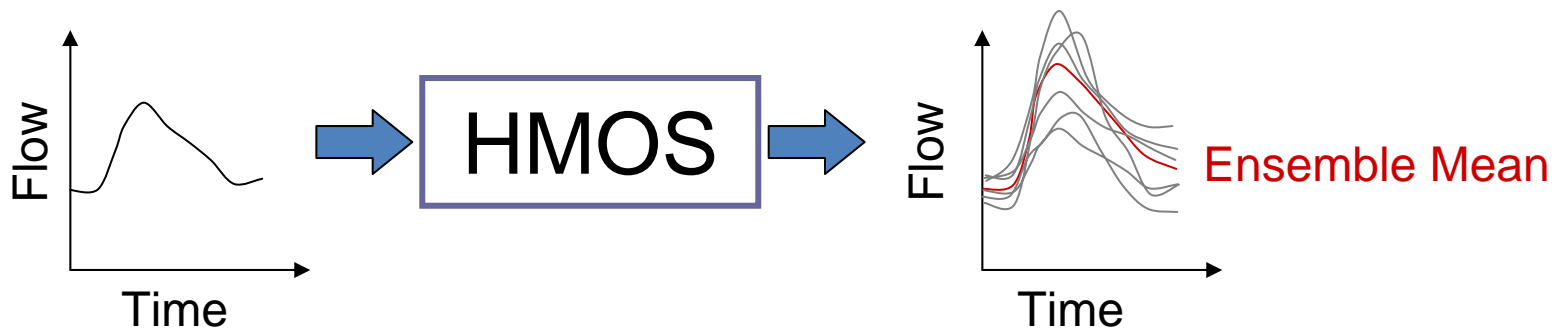
Julie Demargne and James Brown

Data provided by Satish Regonda



HMOS Verification

- HMOS ingests operational single-valued flow forecasts to generate flow ensembles accounting for all forecast uncertainties



Comparison of:

- 6-hr single-valued flow forecasts (HMOS inputs)
- 6-hr ensemble mean flow forecasts and ensemble forecasts (HMOS outputs)

Results from HMOS prototype for QUAO2 basin in ABRFC from July 1997 to Oct. 2008 (w/ missing periods) for 5 lead days

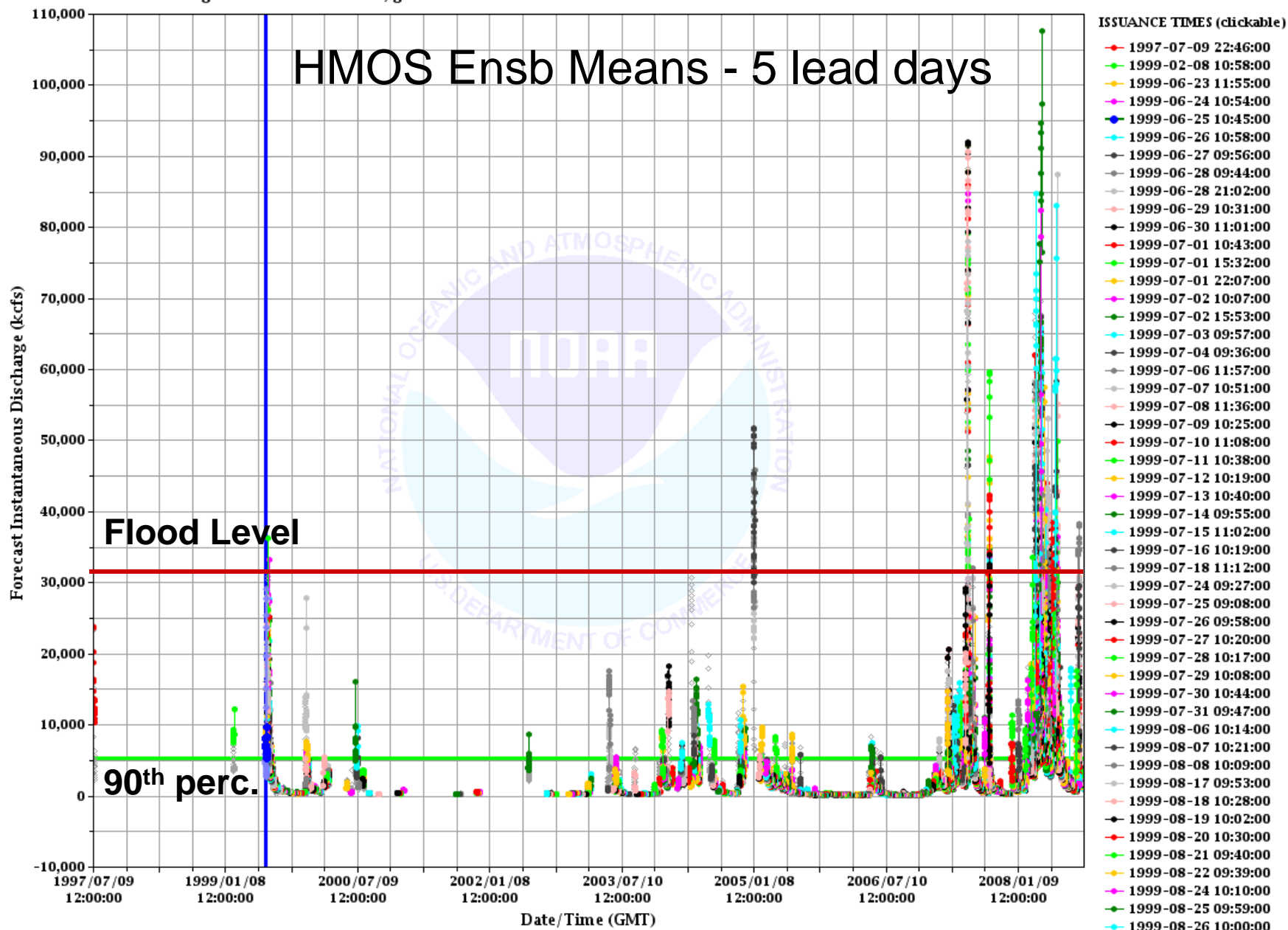
HMOS Verification

- IVP verification:
 - Single-valued flow forecasts
 - Ensemble mean flow forecasts
 - Persistence forecasts
- EVS verification:
 - Ensemble flow forecasts
 - Ensemble mean flow forecasts
- Conditional statistics using 2 thresholds:
 - Flood level: 32,100 cfs
 - 90th percentile of observations: 5,297 cfs

Plot of Forecast and Observed Instantaneous Discharge Time Series for ABRFC
 Time Period: 1997-07-06 14:47:31 GMT - 2008-10-10 14:47:41 GMT
 Lead times: 0 hours - 120 hours
 Location: Quapaw 3 SE [QUAO2(QTIEMZZ)]
 Forecast Categories: less than 5297.0, greater than 5297.0 kcfs

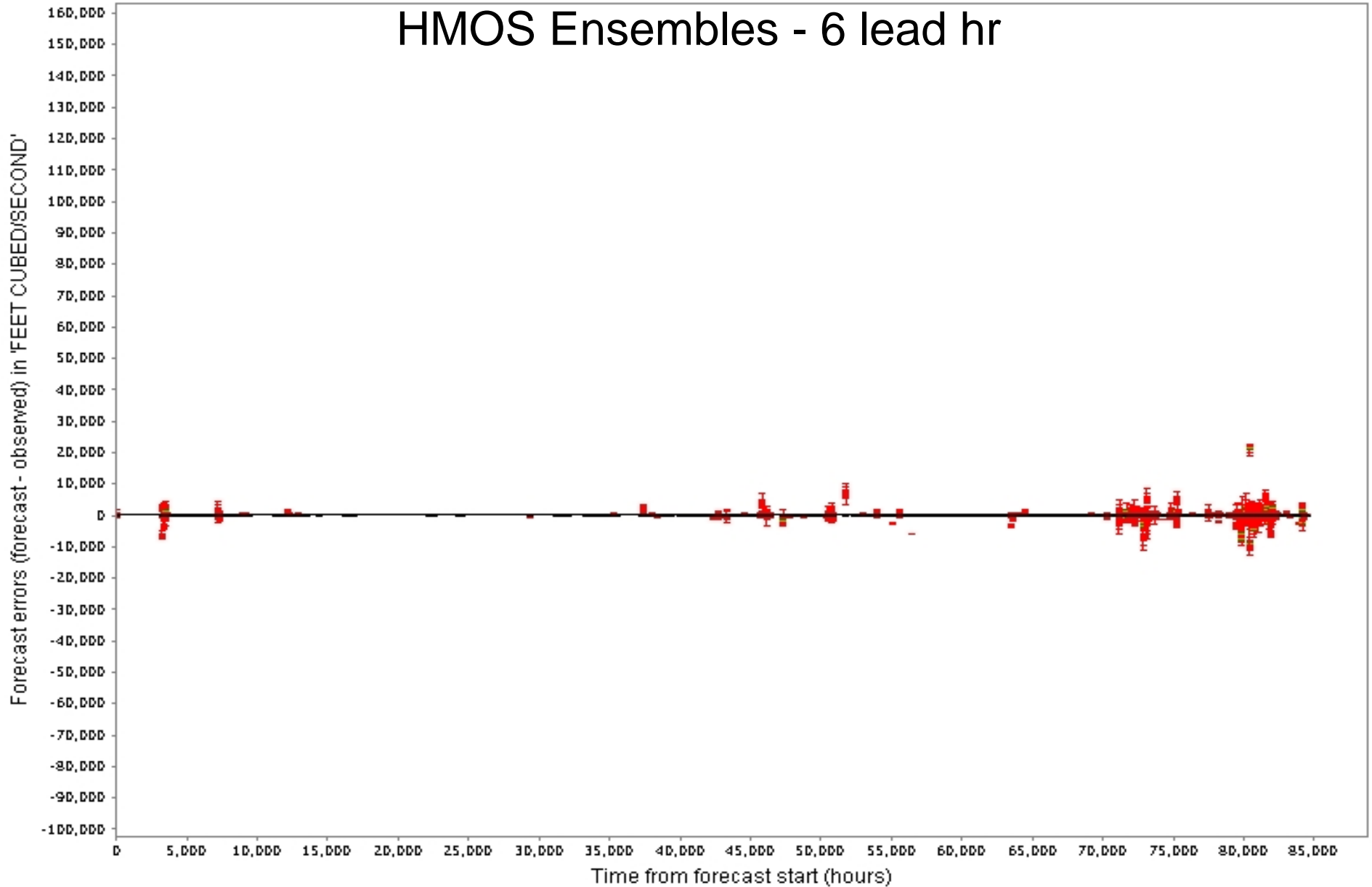
IVP Time Series Plot

All verification data



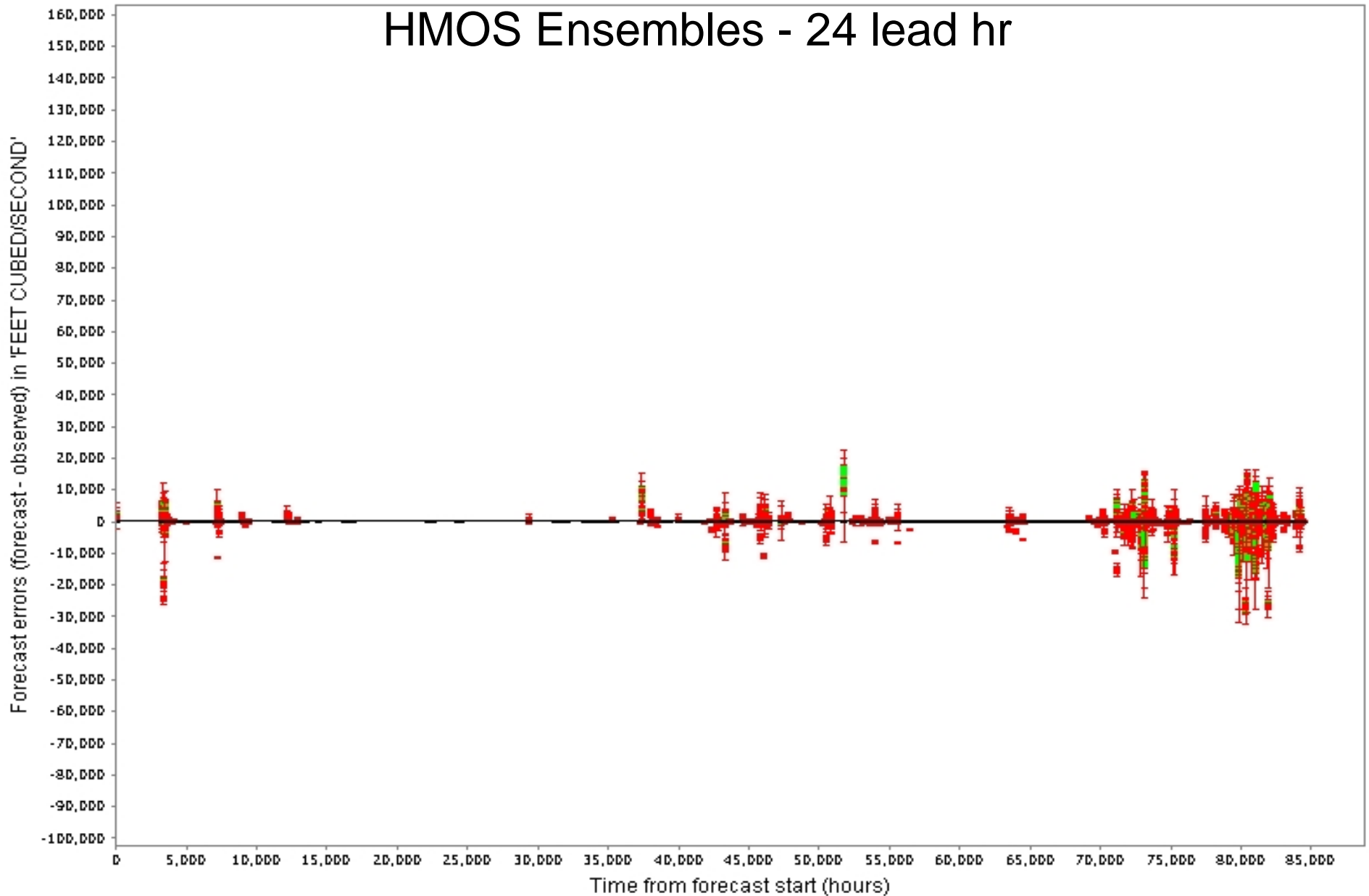
EVS box plots with time

Modified box plot of ensemble forecast errors against forecast time for one lead time.
QUAO2.6_hour.Streamflow.HMOS at lead hour 6



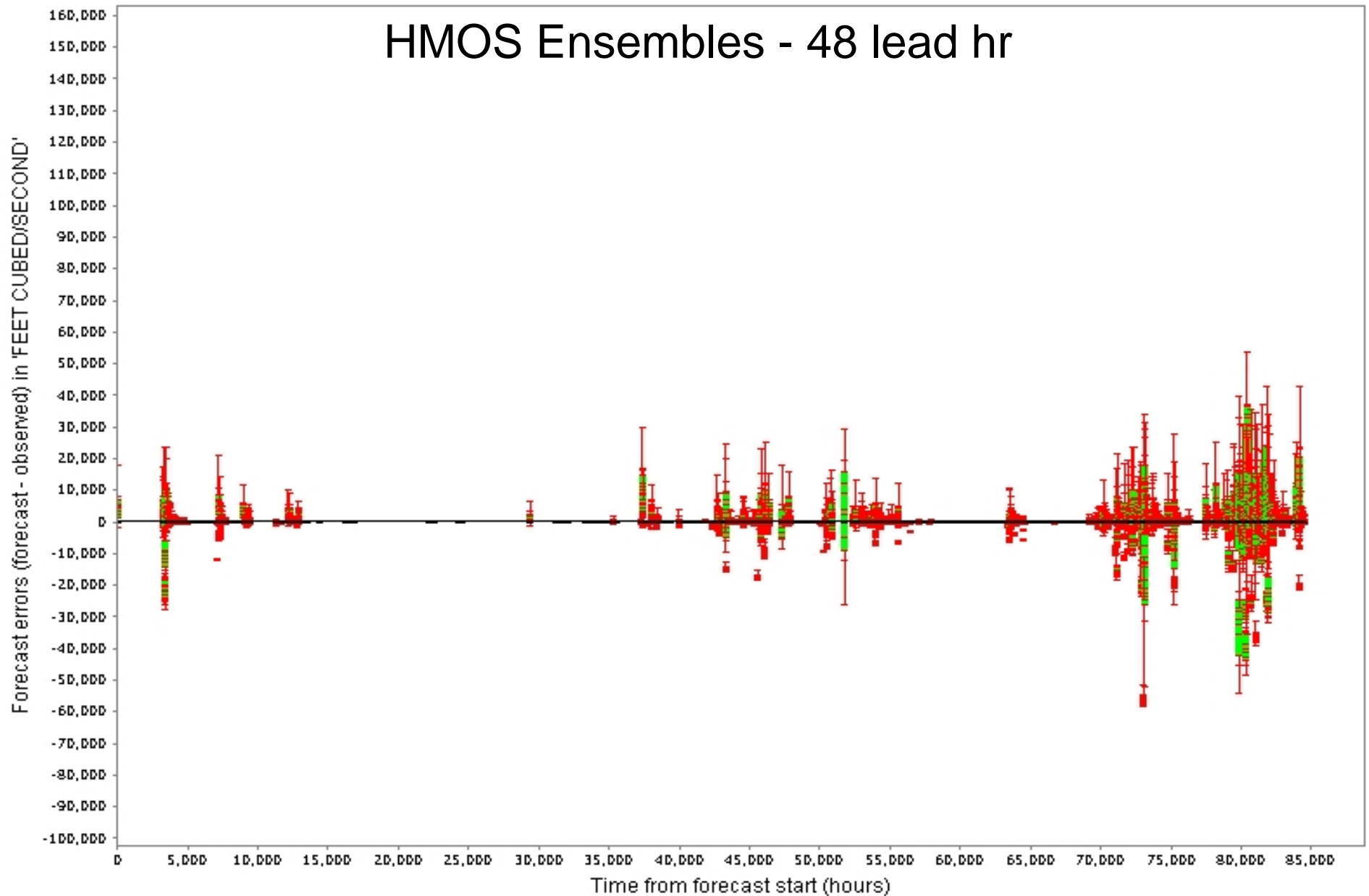
EVS box plots with time

Modified box plot of ensemble forecast errors against forecast time for one lead time.
QUAO2.6_hour.Streamflow.HMOS at lead hour 24



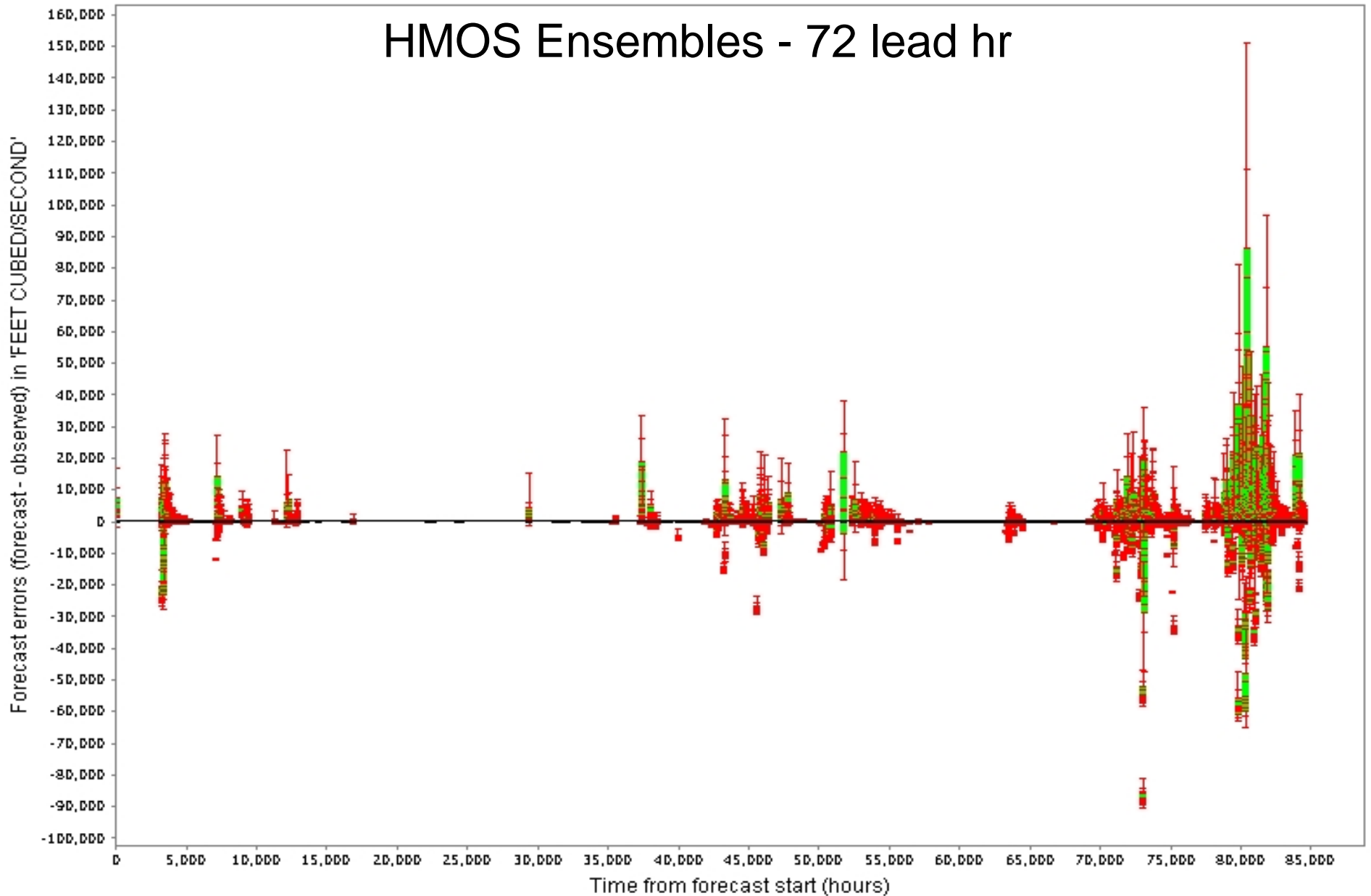
EVS box plots with time

Modified box plot of ensemble forecast errors against forecast time for one lead time.
QUAO2.6_hour.Streamflow.HMOS at lead hour 48



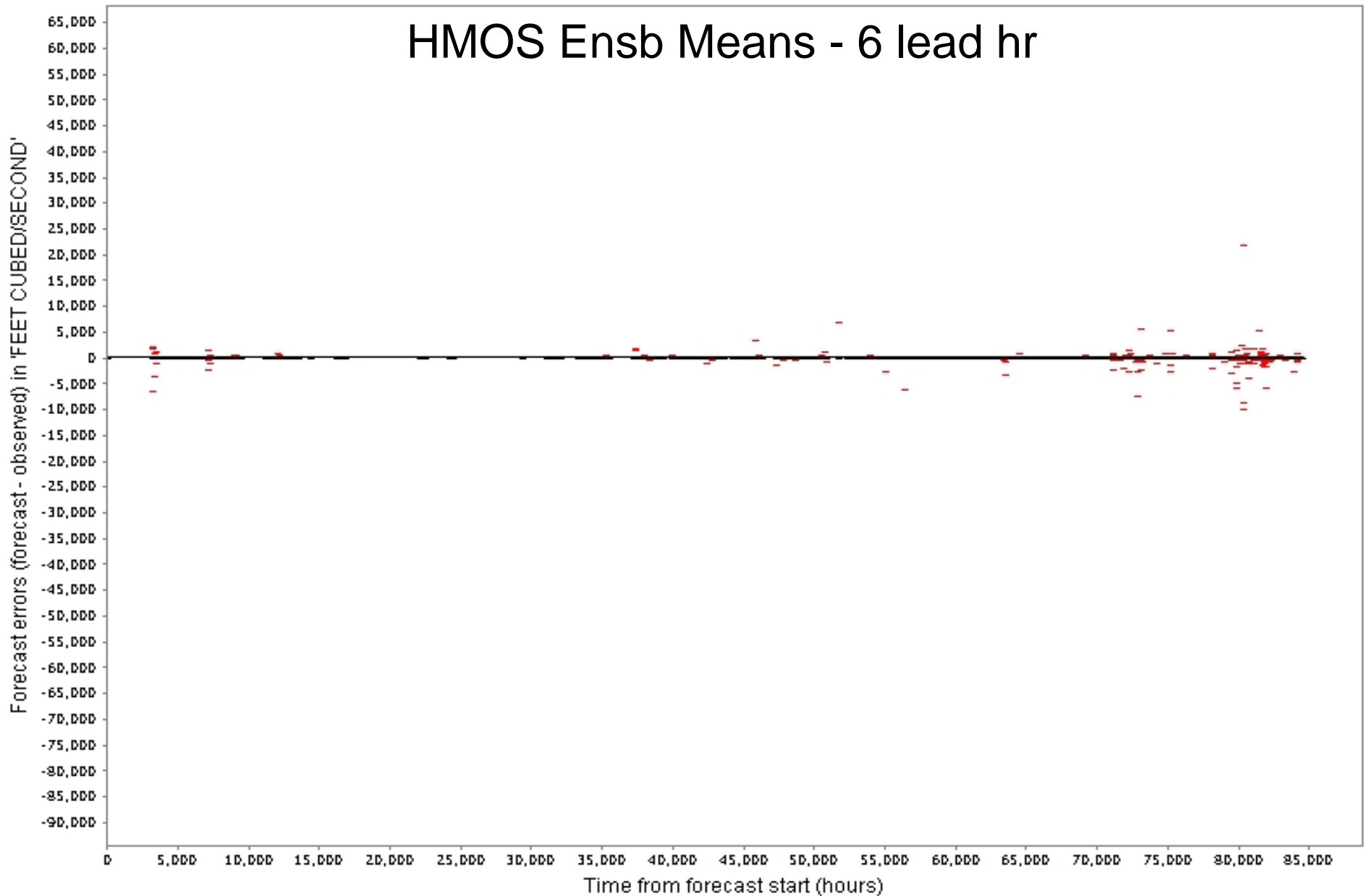
EVS box plots with time

Modified box plot of ensemble forecast errors against forecast time for one lead time.
QUAO2.6_hour.Streamflow.HMOS at lead hour 72



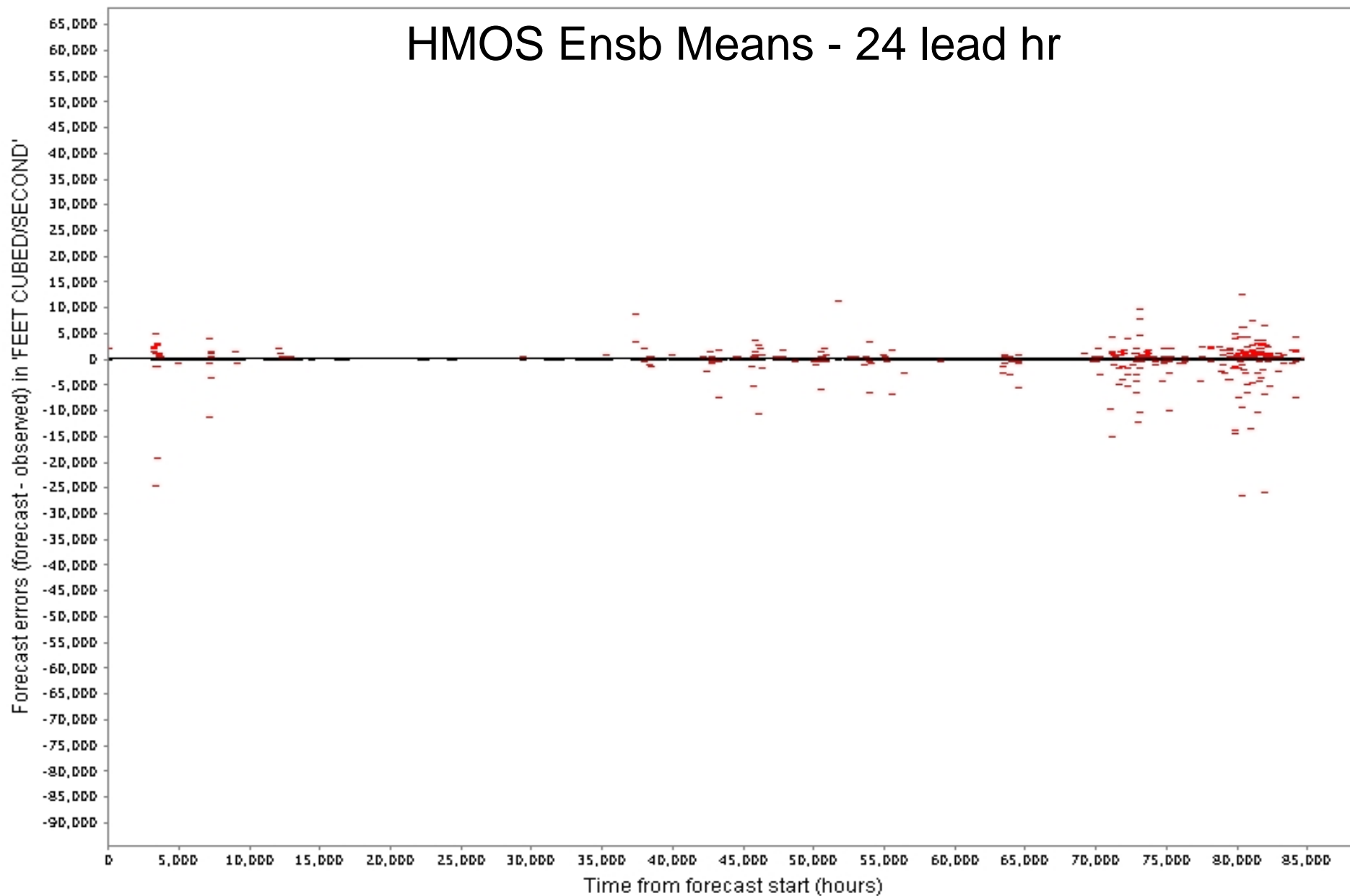
EVS box plots with time

Modified box plot of ensemble forecast errors against forecast time for one lead time.
QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 6



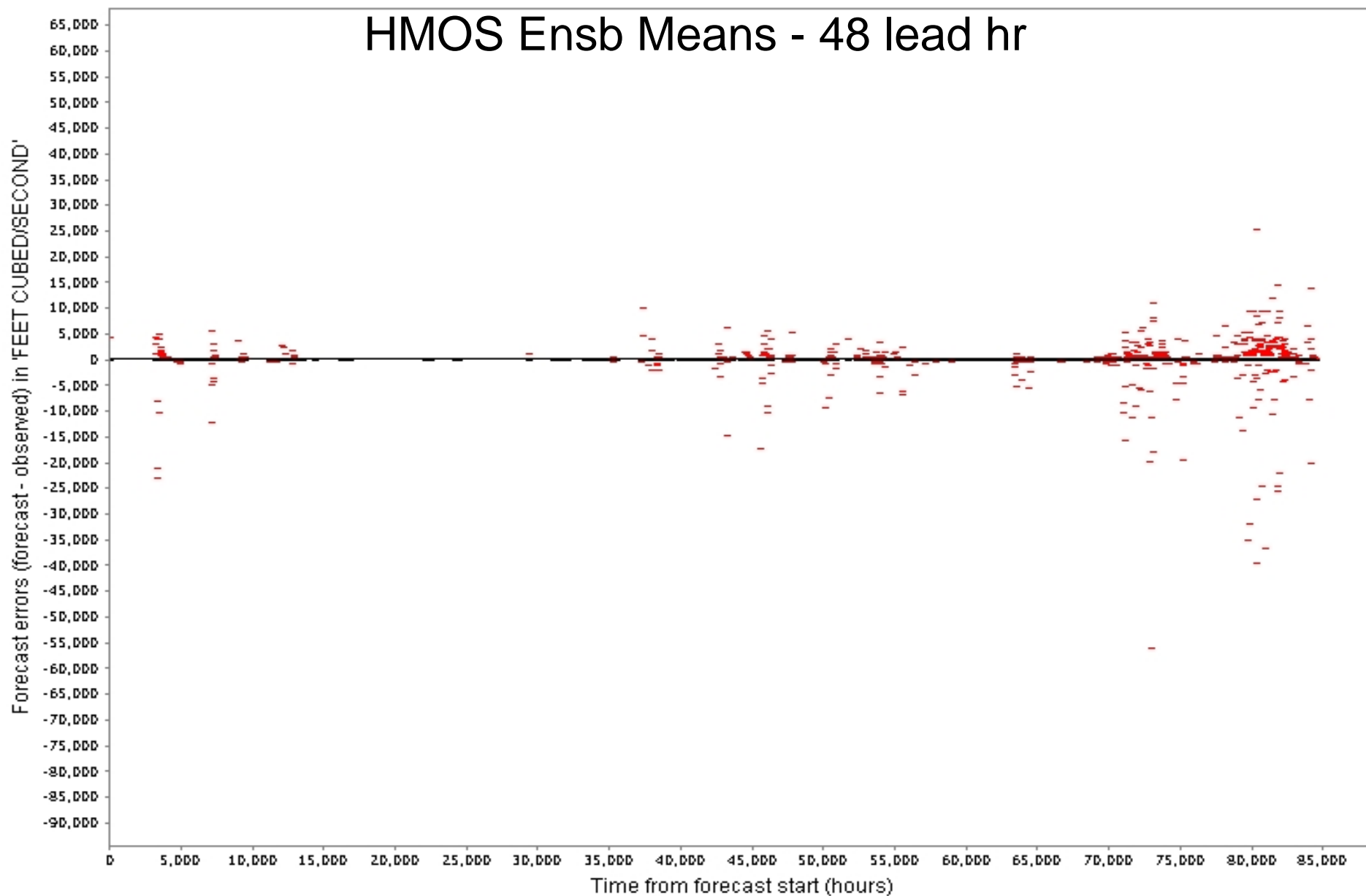
EVS box plots with time

Modified box plot of ensemble forecast errors against forecast time for one lead time.
QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 24



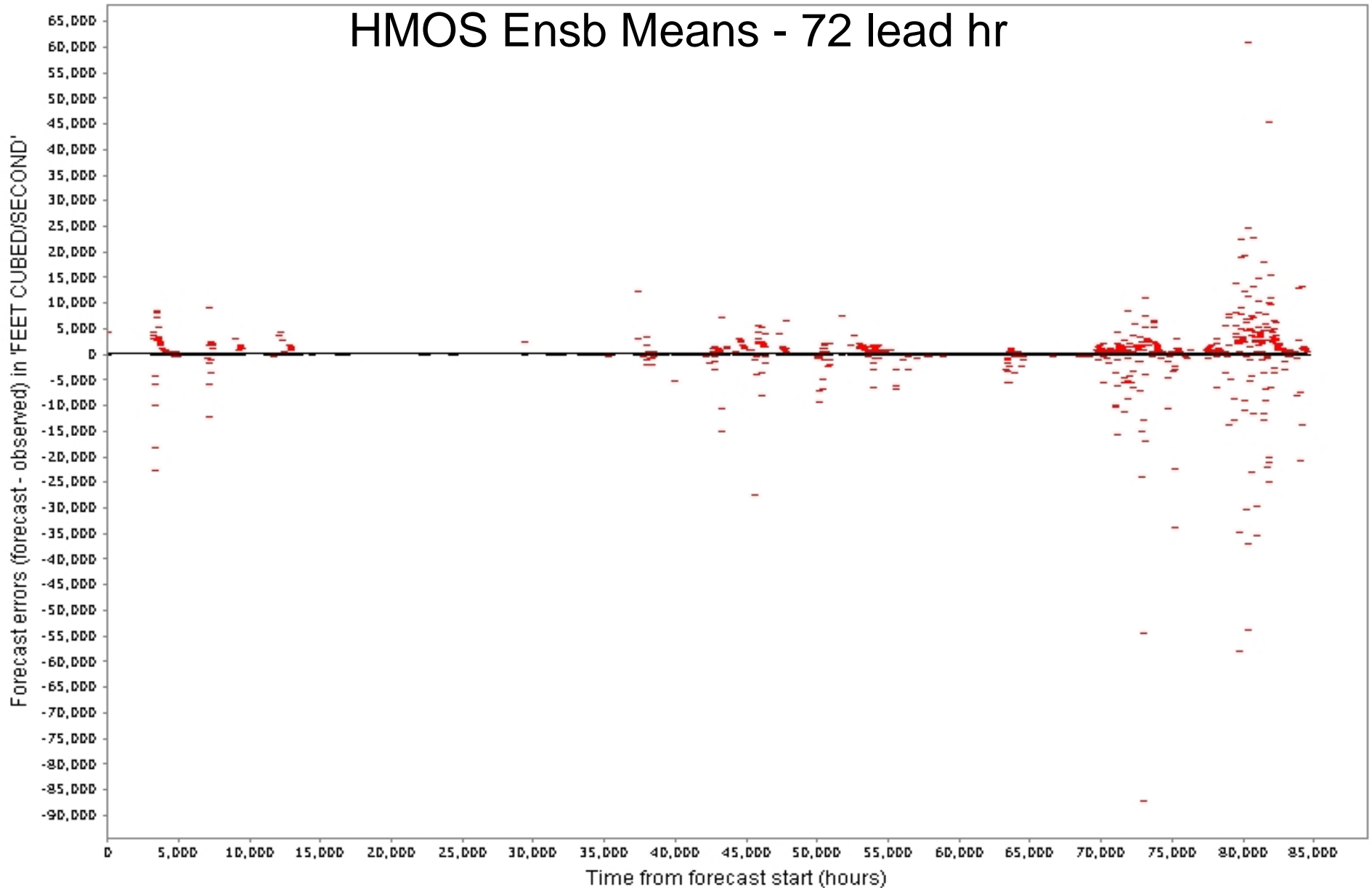
EVS box plots with time

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QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 48



EVS box plots with time

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QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 72

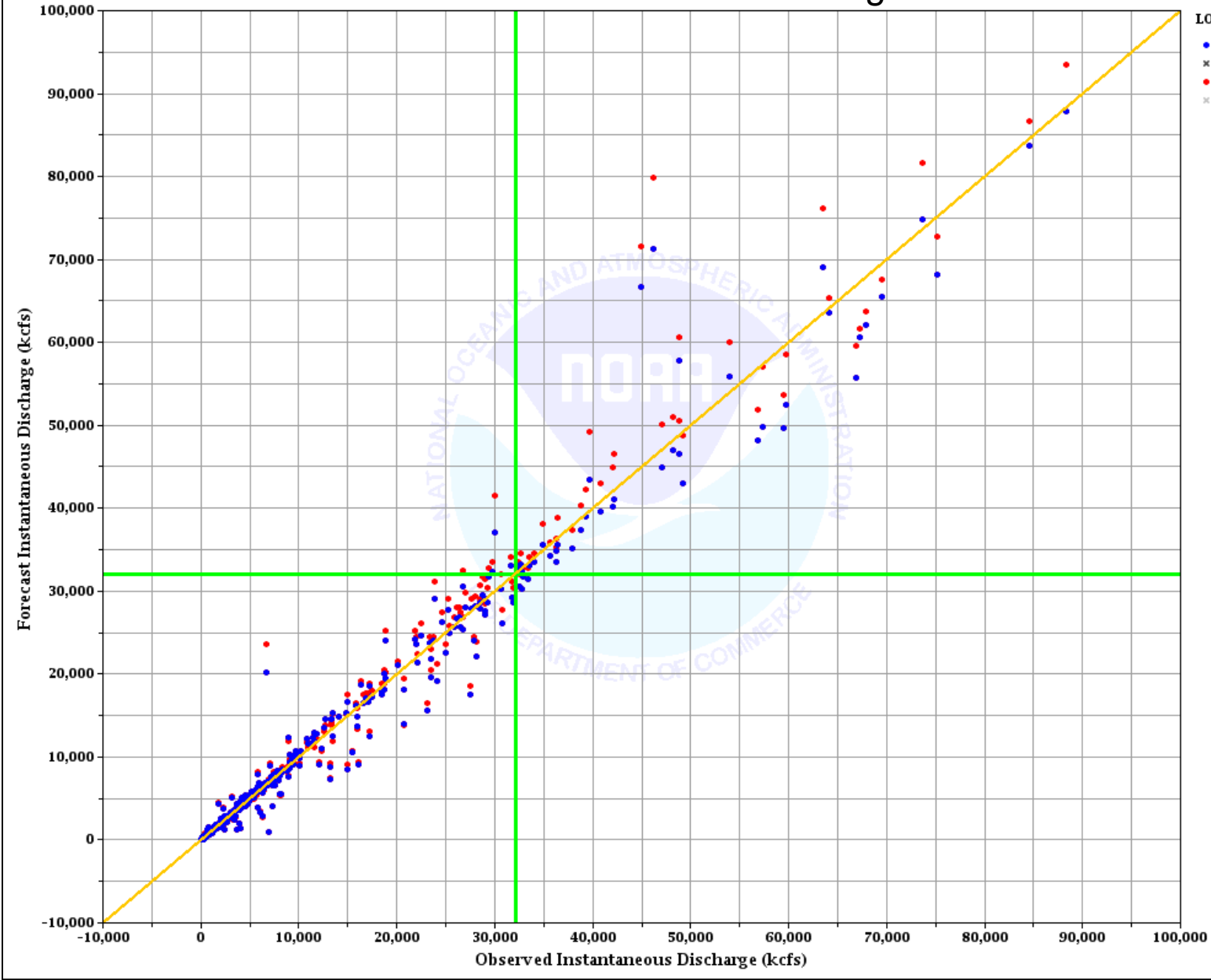


IVP Scatter Plot for 6 hr lead time

Plot of Forecast-Observed Instantaneous Discharge Data Pairs for ABRFC
Time Period: 1997-07-06 08:29:11 GMT - 2008-10-10 08:29:23 GMT
Lead times: 0 hours - 6 hours
Selected Location: Quapaw 3 SE [QUAO2(QTIEMZZ)]

Blue: HMOS Ensemble Means
Red: Single-valued forecasts

LOCATIONS
• Selected Pairs
x Selected Bad Pairs
• All Pairs
x Bad Pairs

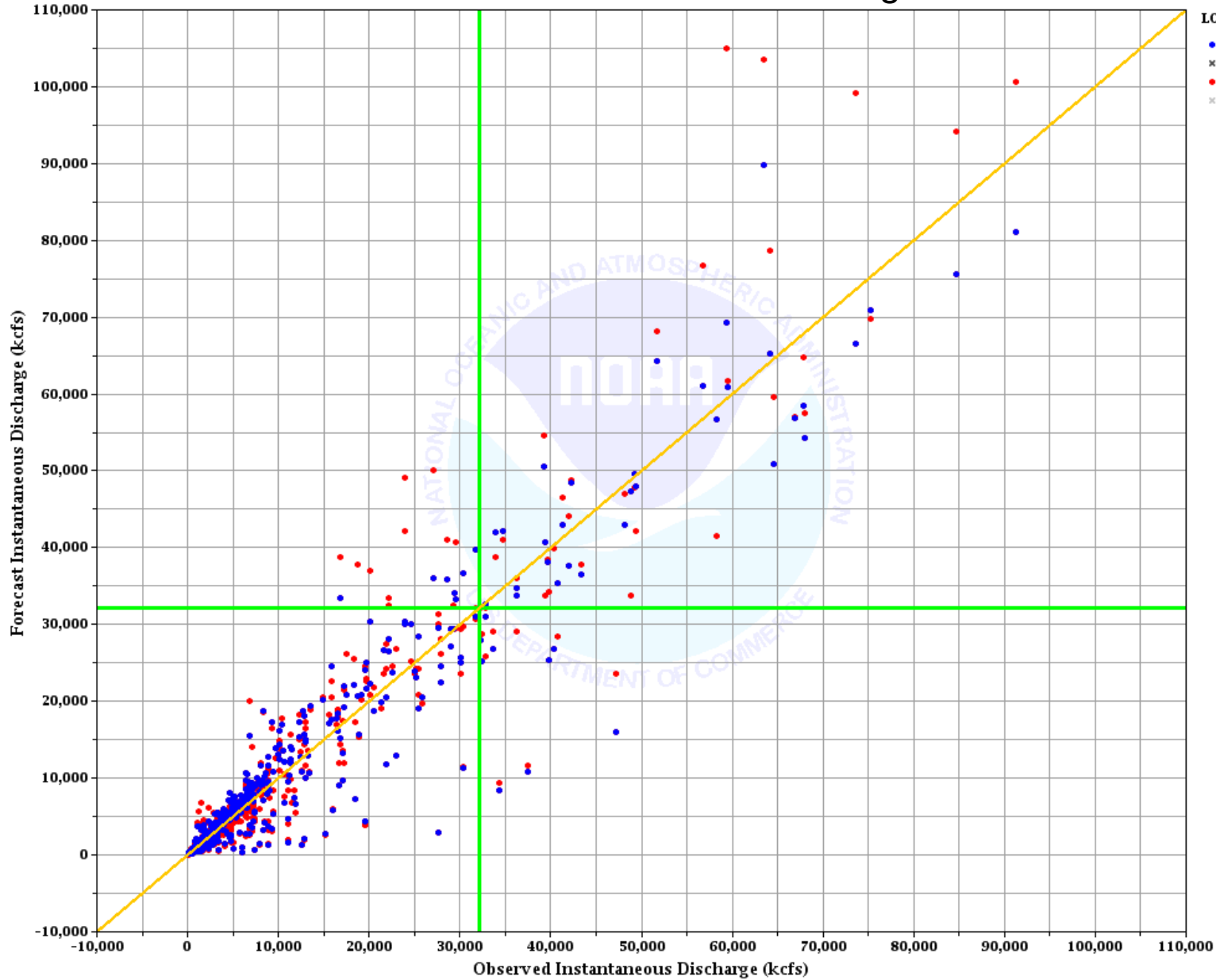


IVP Scatter Plot for 24 hr lead time

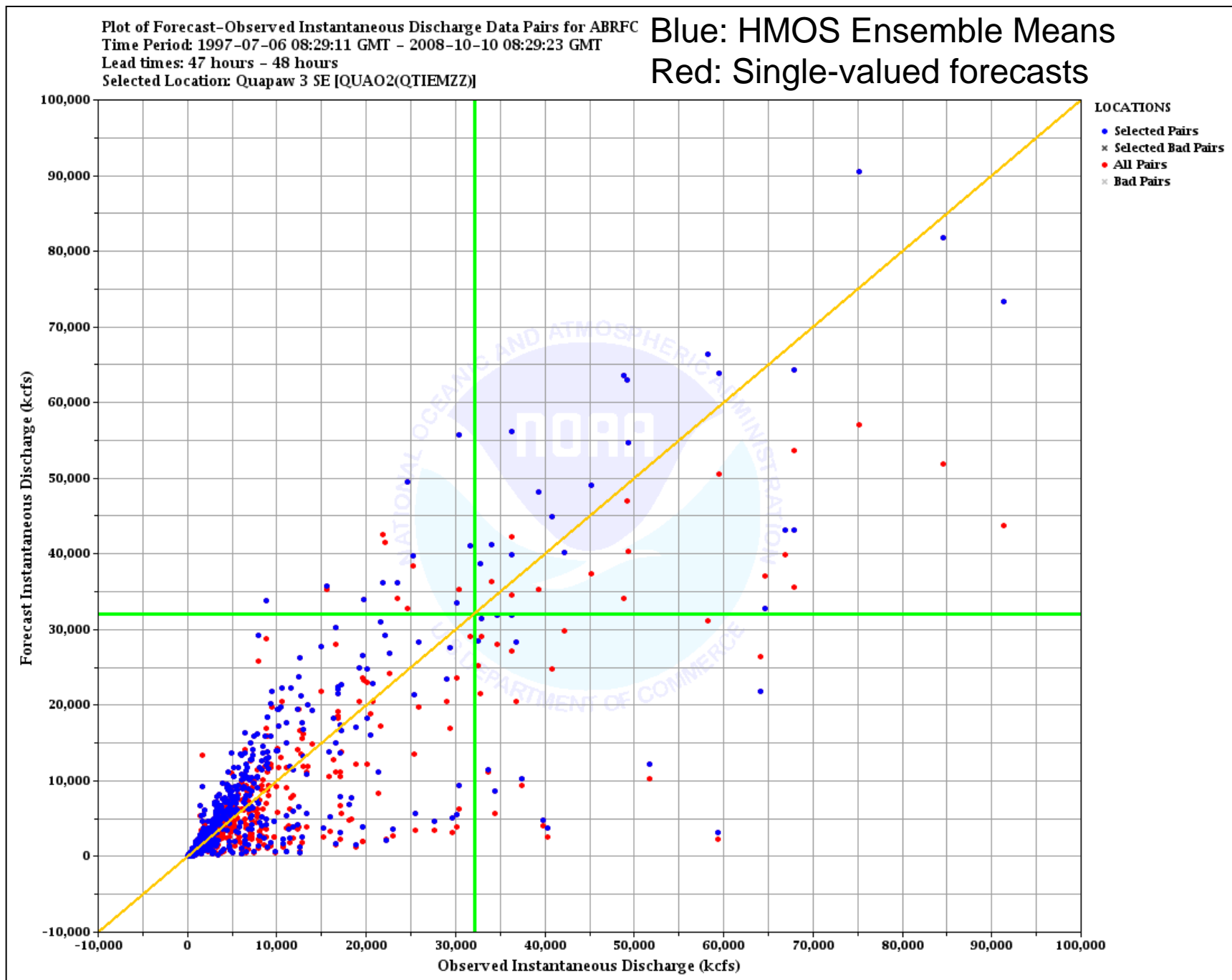
Plot of Forecast-Observed Instantaneous Discharge Data Pairs for ABRFC
Time Period: 1997-07-06 08:29:11 GMT - 2008-10-10 08:29:23 GMT
Lead times: 23 hours - 24 hours
Selected Location: Quapaw 3 SE [QUAO2(QTIEMZZ)]

Blue: HMOS Ensemble Means
Red: Single-valued forecasts

- LOCATIONS
- Selected Pairs
 - × Selected Bad Pairs
 - All Pairs
 - × Bad Pairs

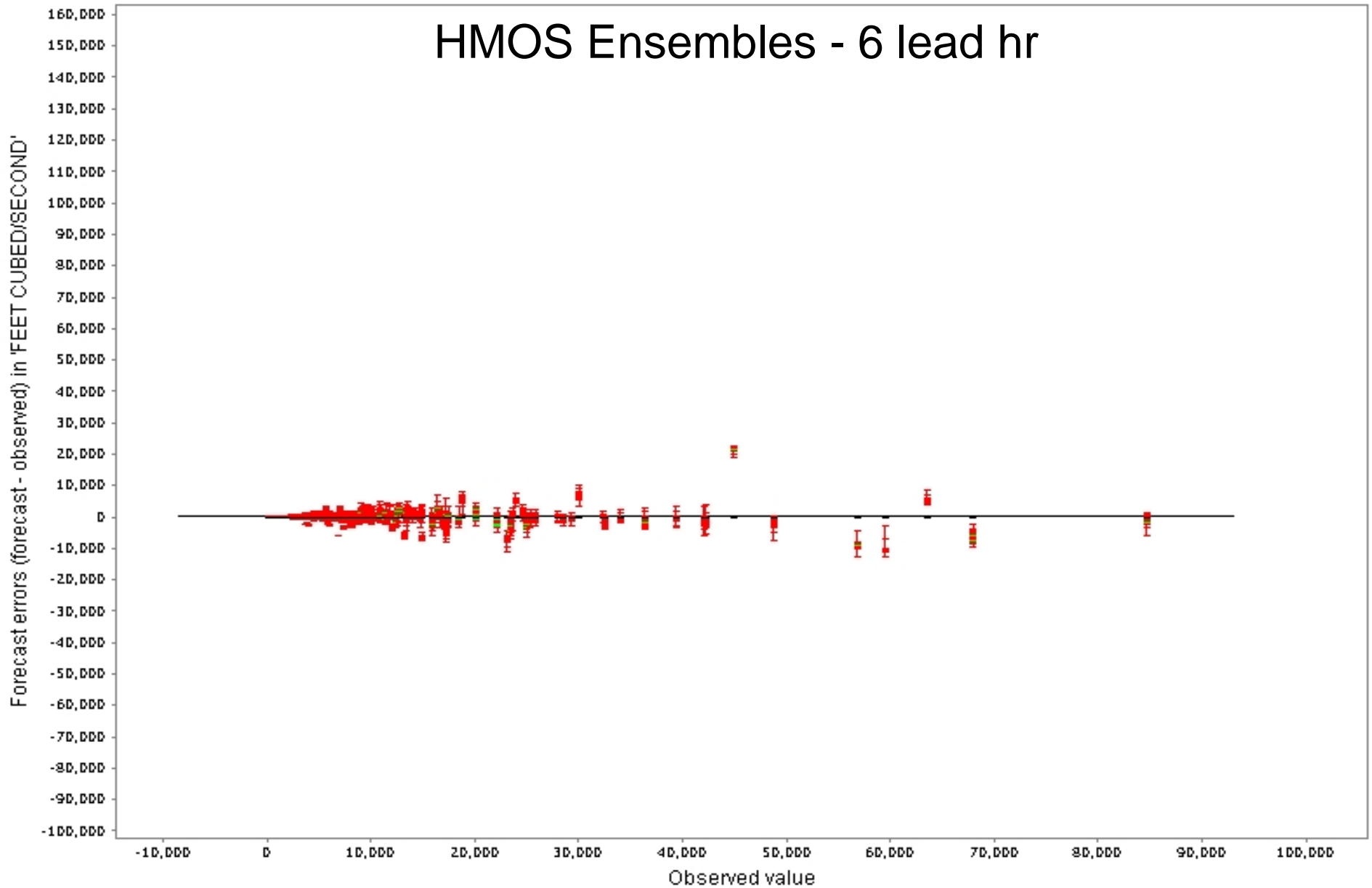


IVP Scatter Plot for 48 hr lead time



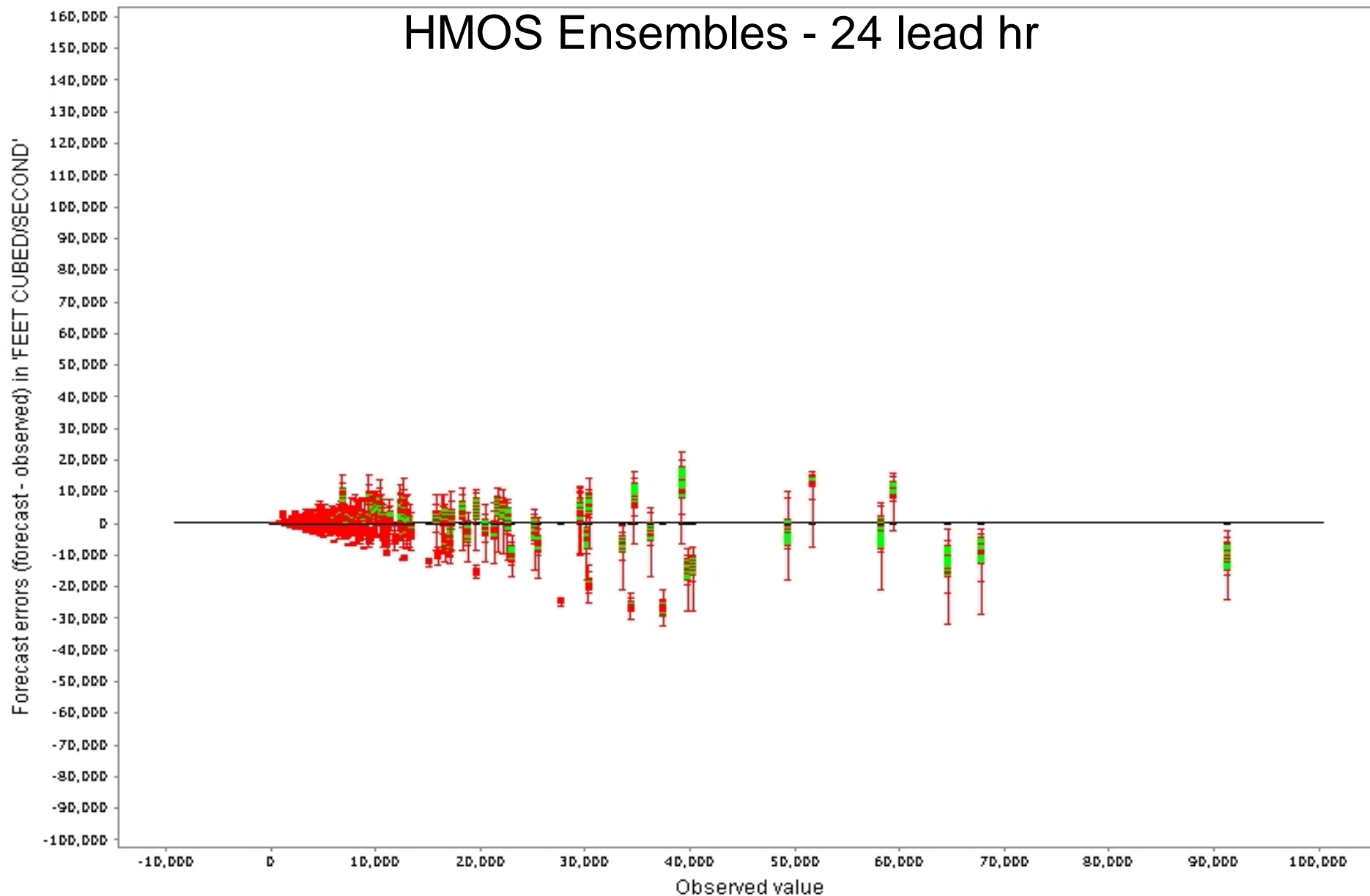
EVS box plots with observed value

Modified box plot of ensemble forecast errors against observed value.
QUAO2.6_hour.Streamflow.HMOS at lead hour 6



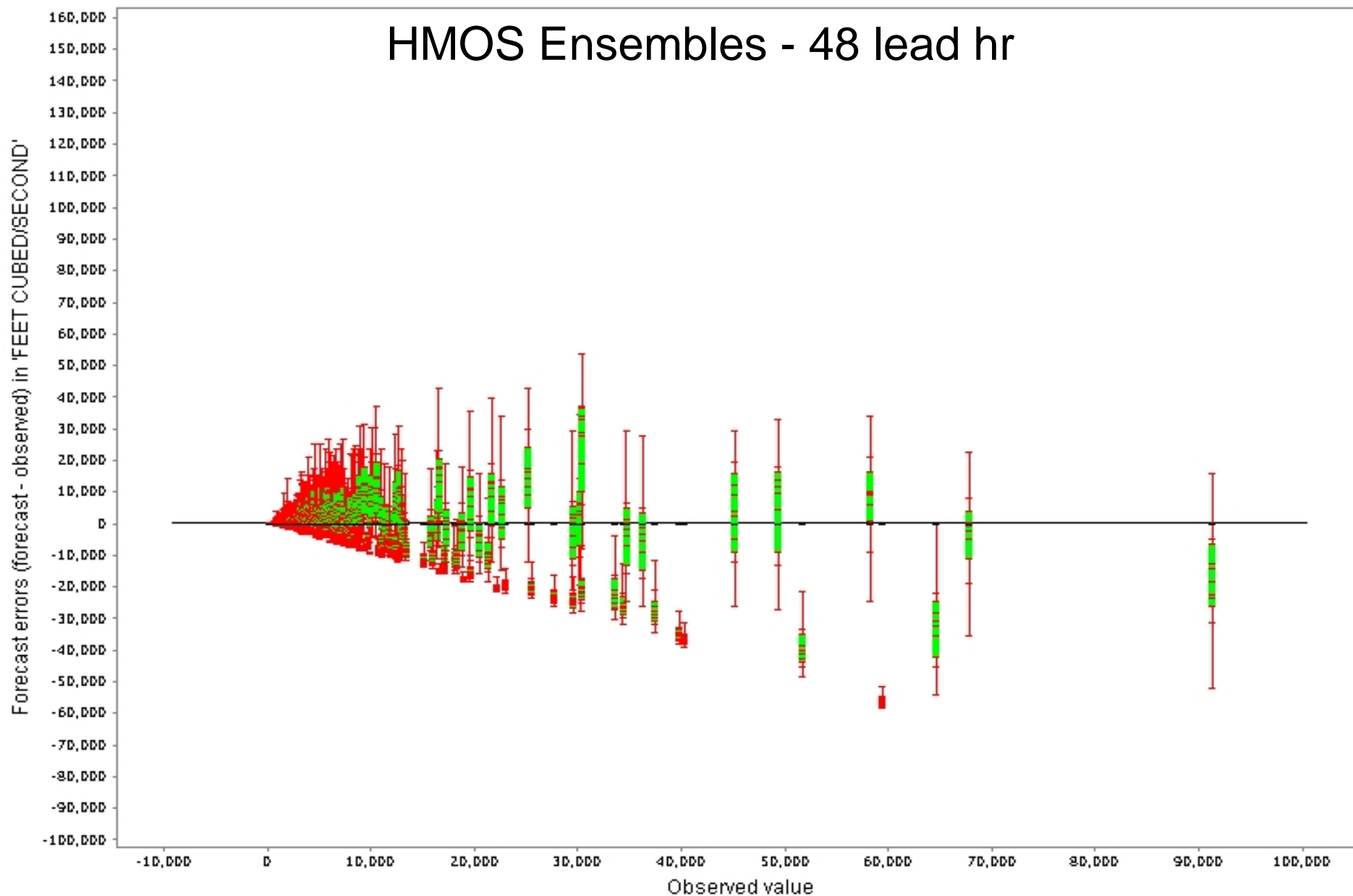
EVS box plots with observed value

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QUAO2.6_hour.Streamflow.HMOS at lead hour 24



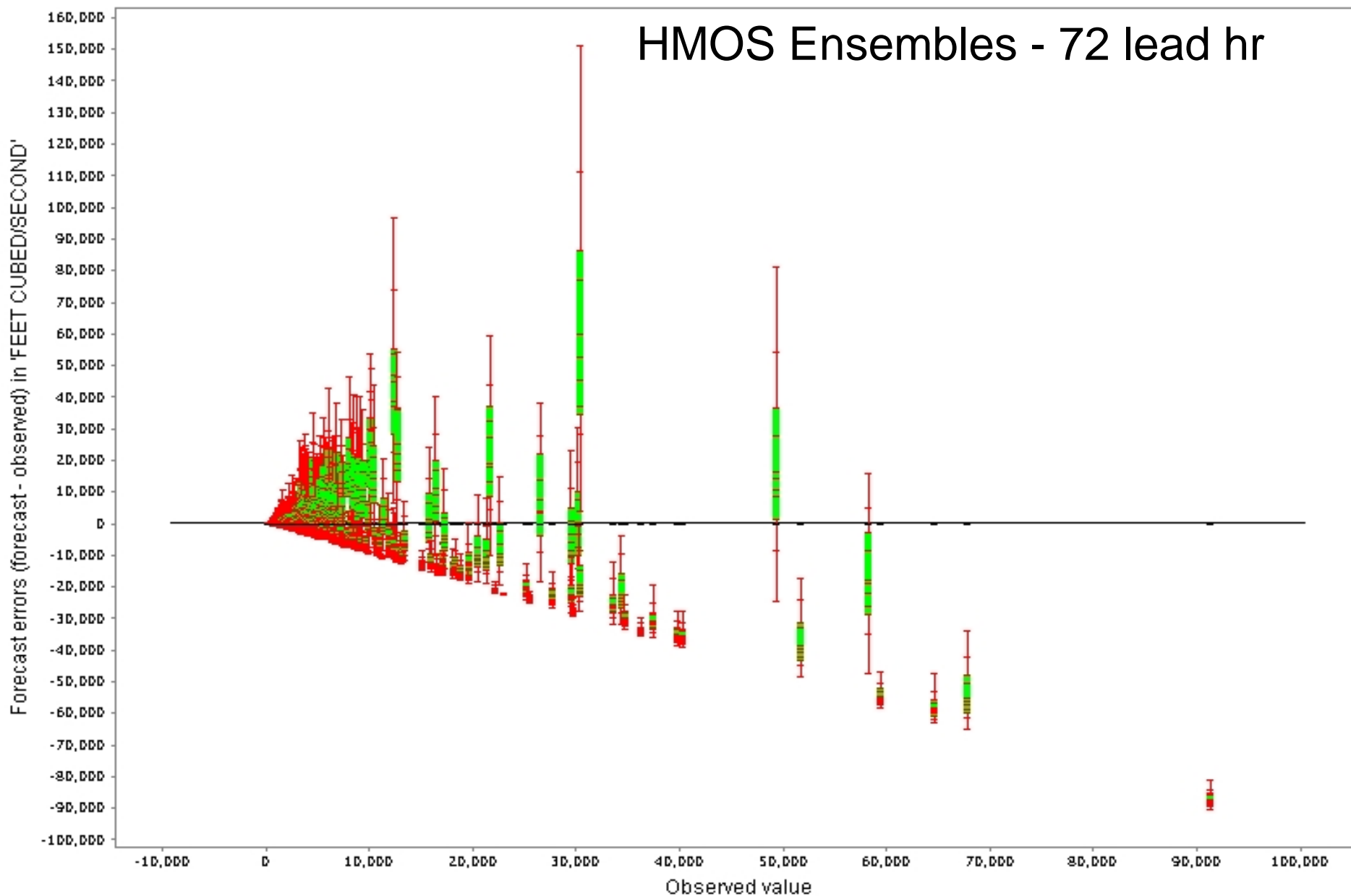
EVS box plots with observed value

Modified box plot of ensemble forecast errors against observed value.
QUAO2.6_hour.Streamflow.HMOS at lead hour 48



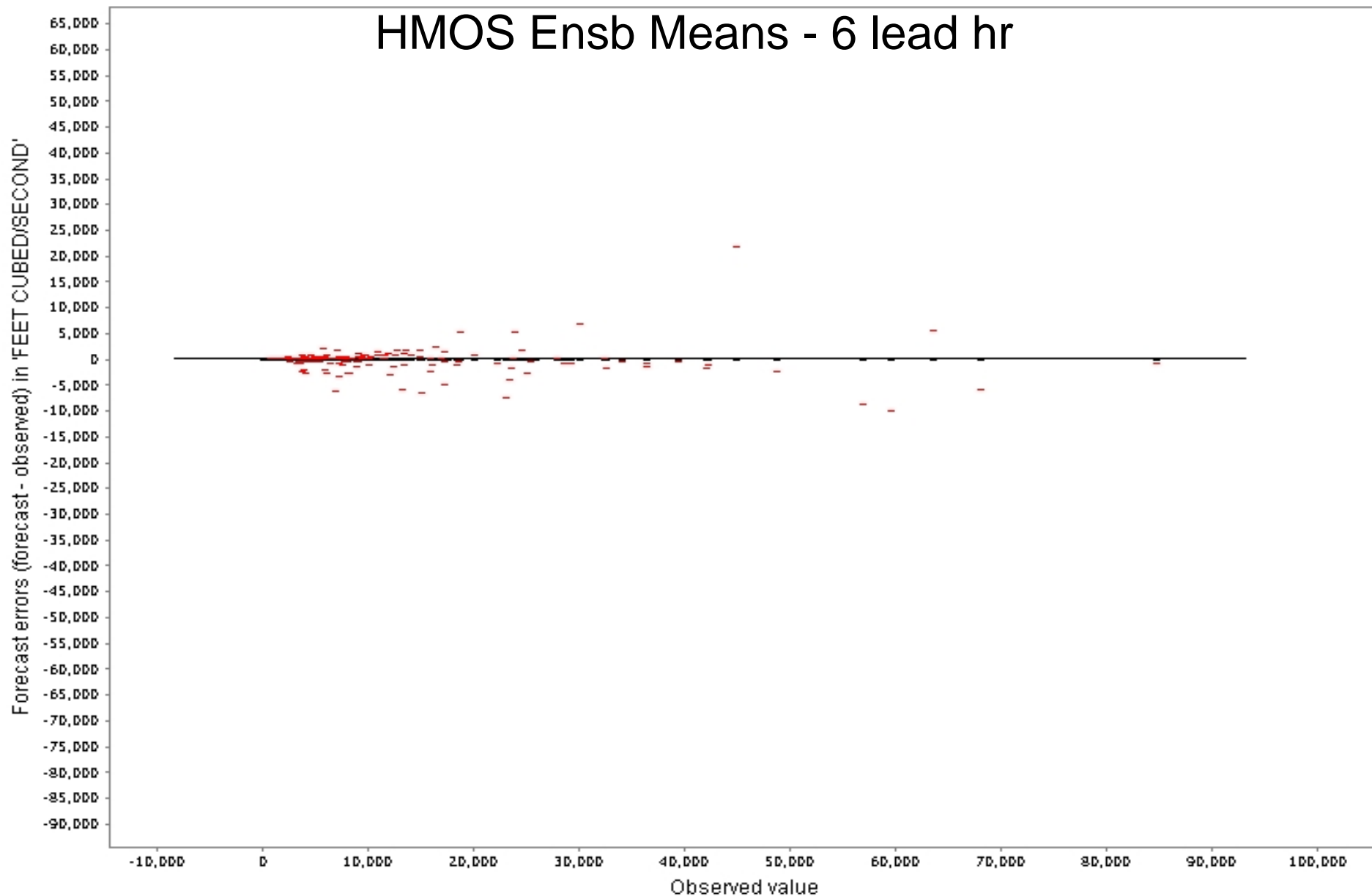
EVS box plots with observed value

Modified box plot of ensemble forecast errors against observed value.
QUAO2.6_hour.Streamflow.HMOS at lead hour 72



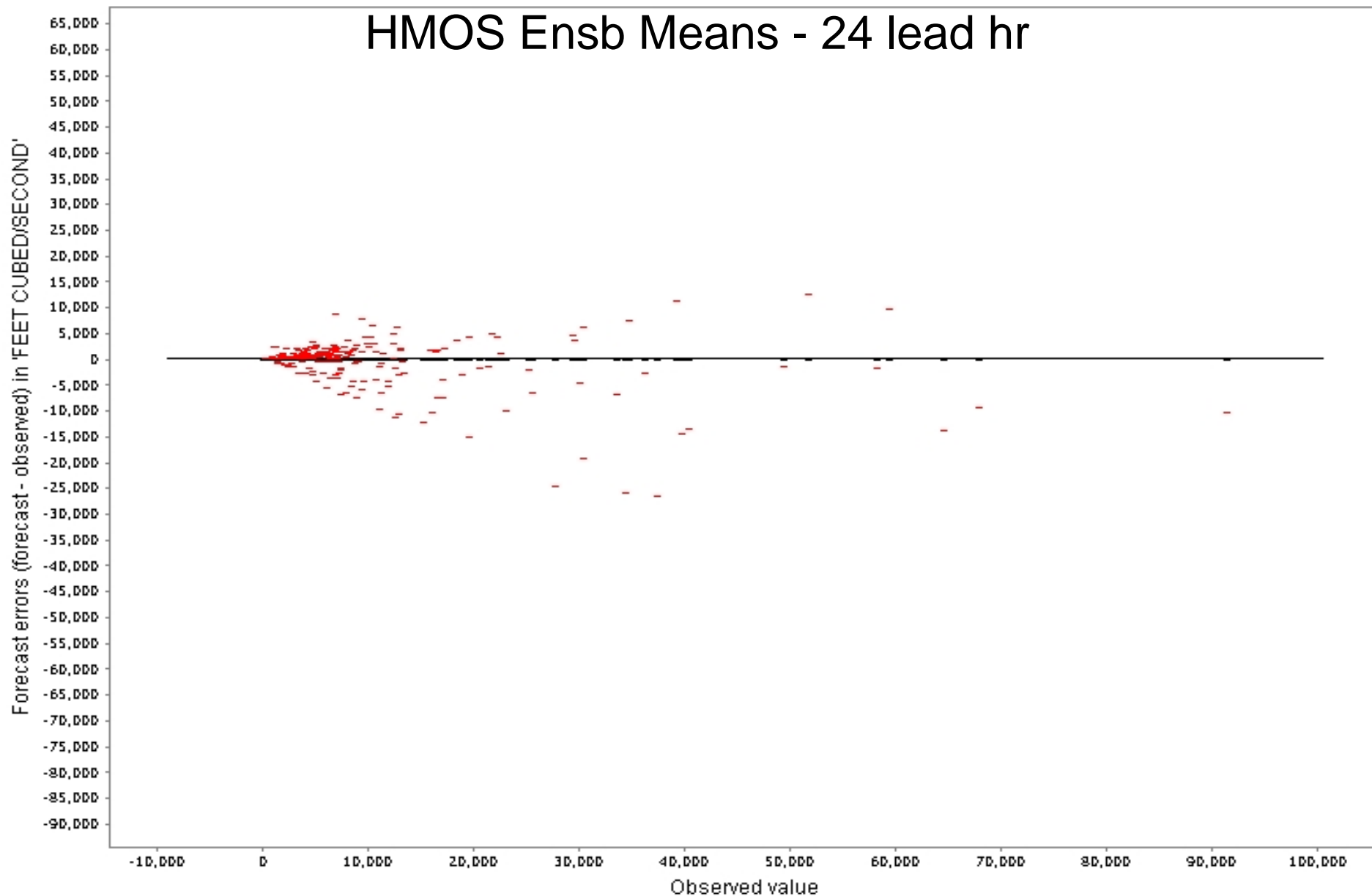
EVS box plots with observed value

Modified box plot of ensemble forecast errors against observed value.
QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 6



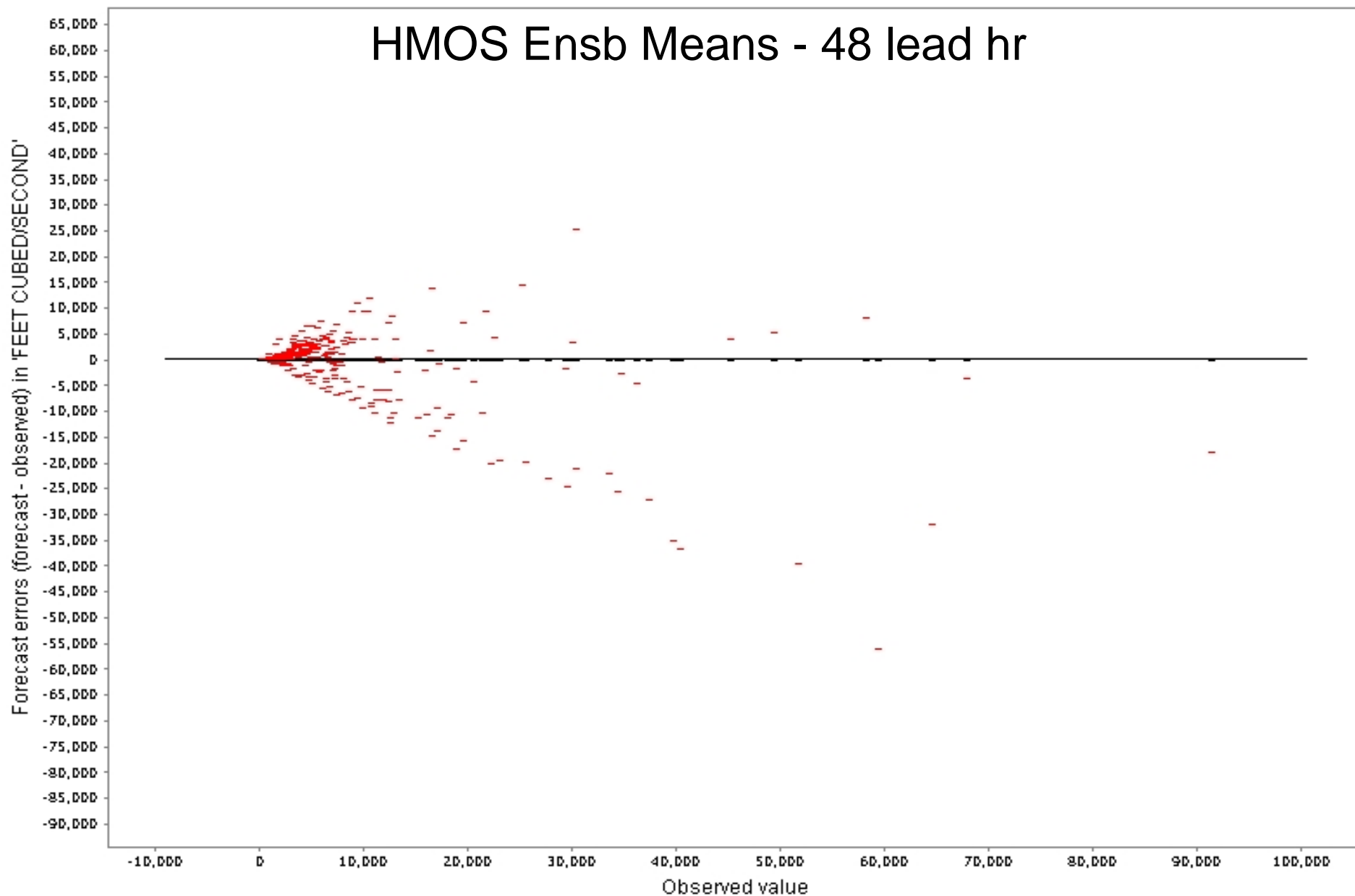
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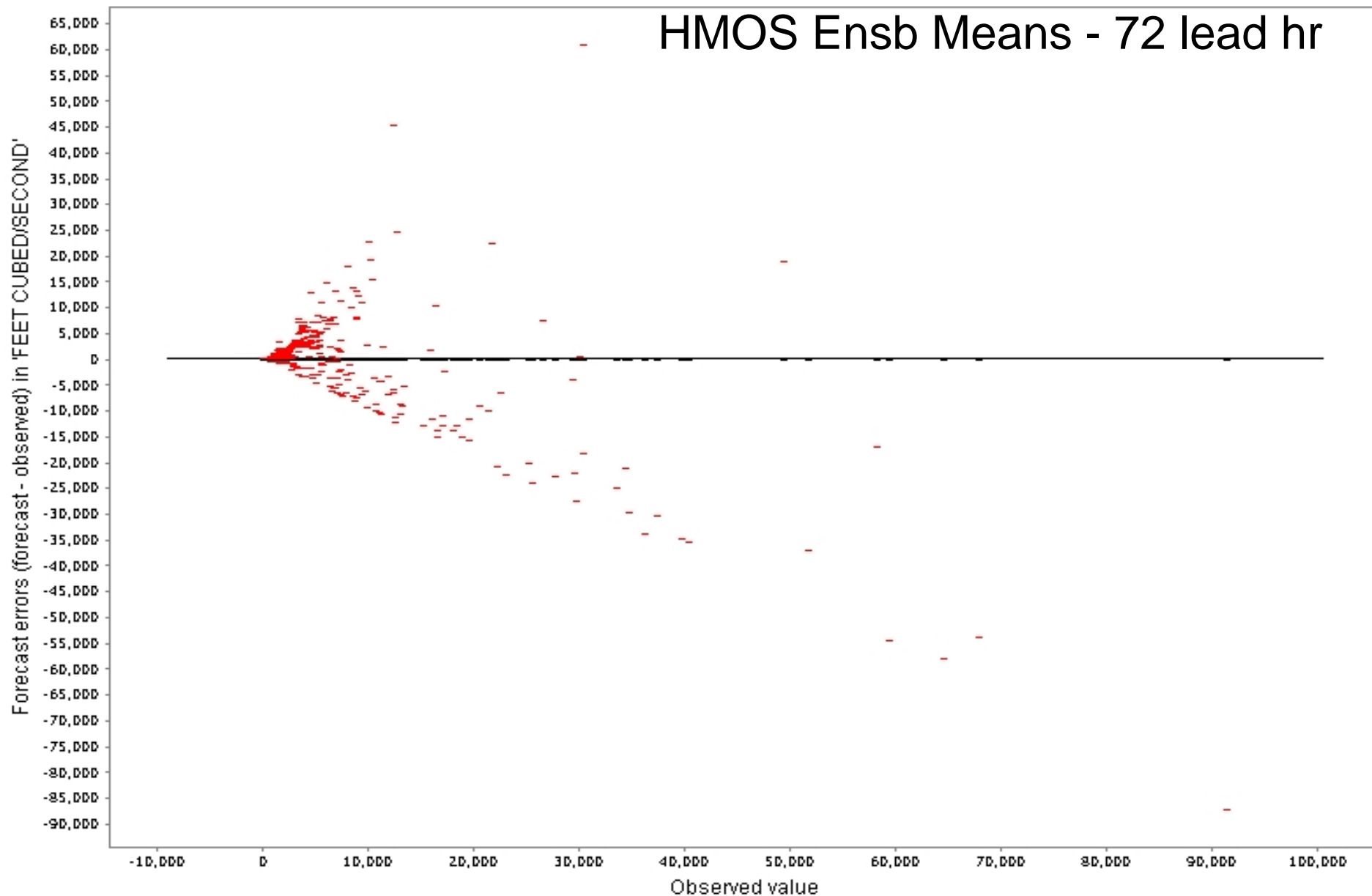
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EVS box plots with observed value

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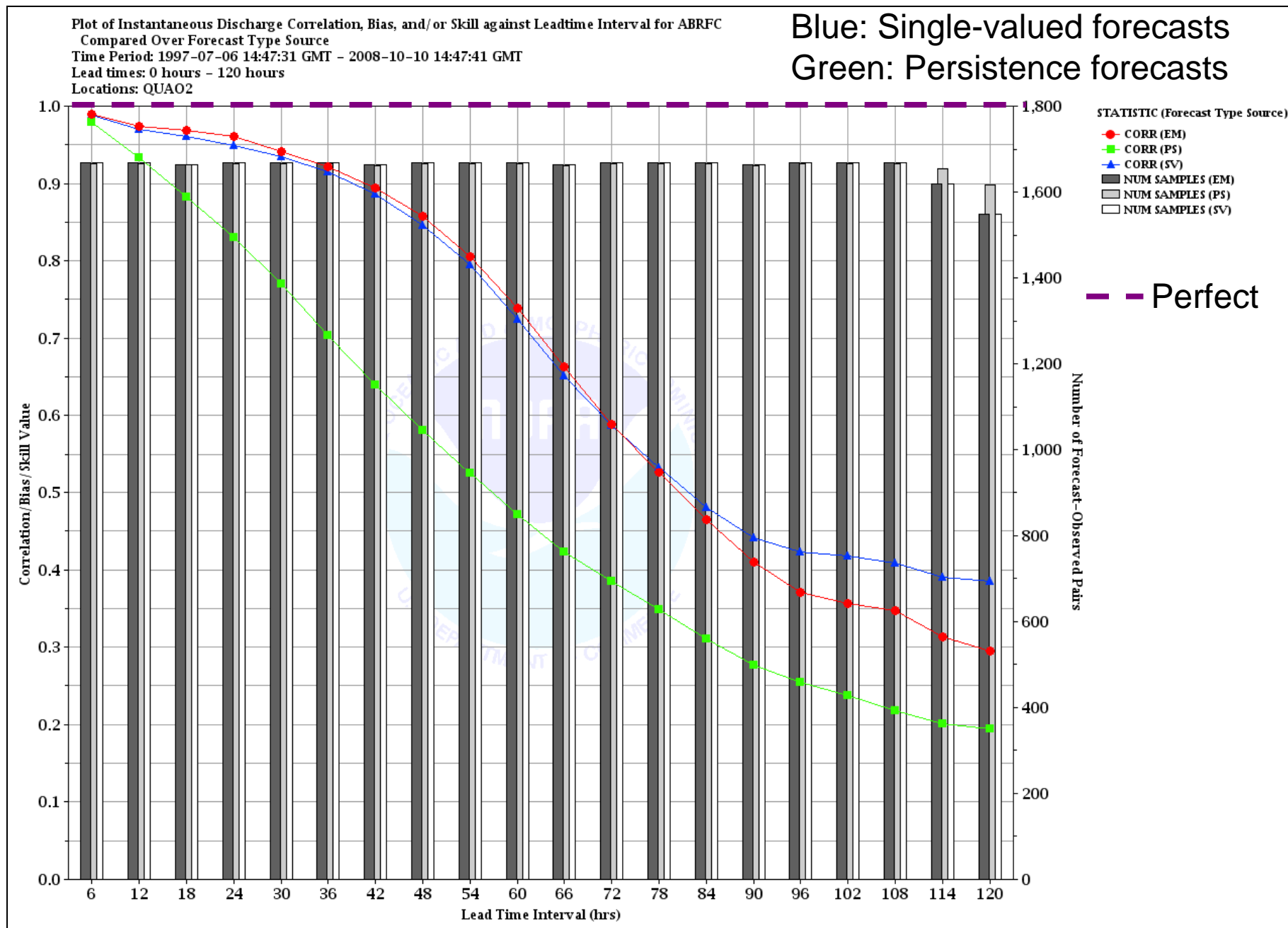


IVP Statistics by lead time - Correlation

Red: HMOS Ensemble Means

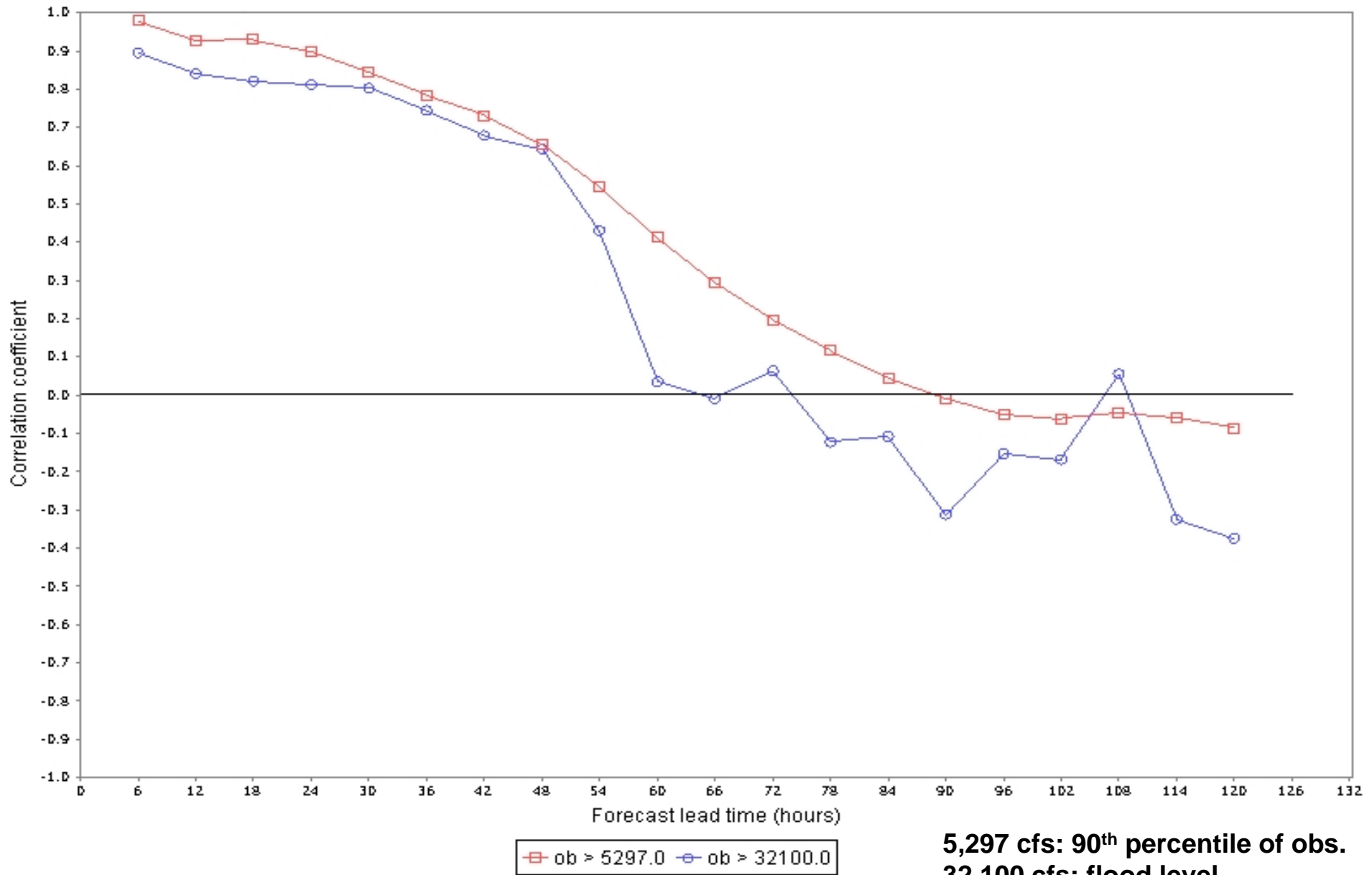
Blue: Single-valued forecasts

Green: Persistence forecasts

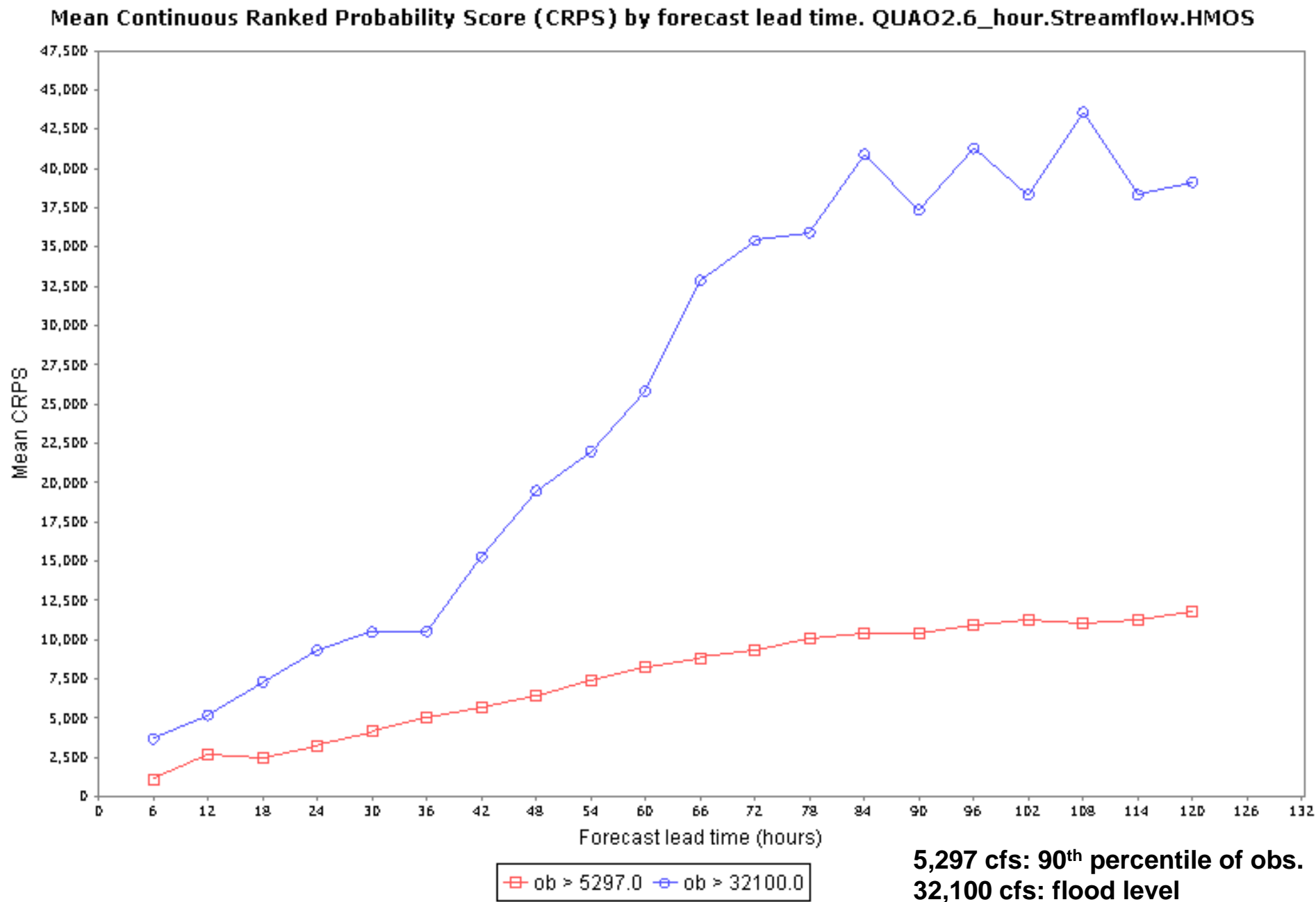


Correlation for HMOS Ensb Means

Correlation of the observations and ensemble mean forecast by forecast lead time.
QUAO2.6_hour.Streamflow.HMOS

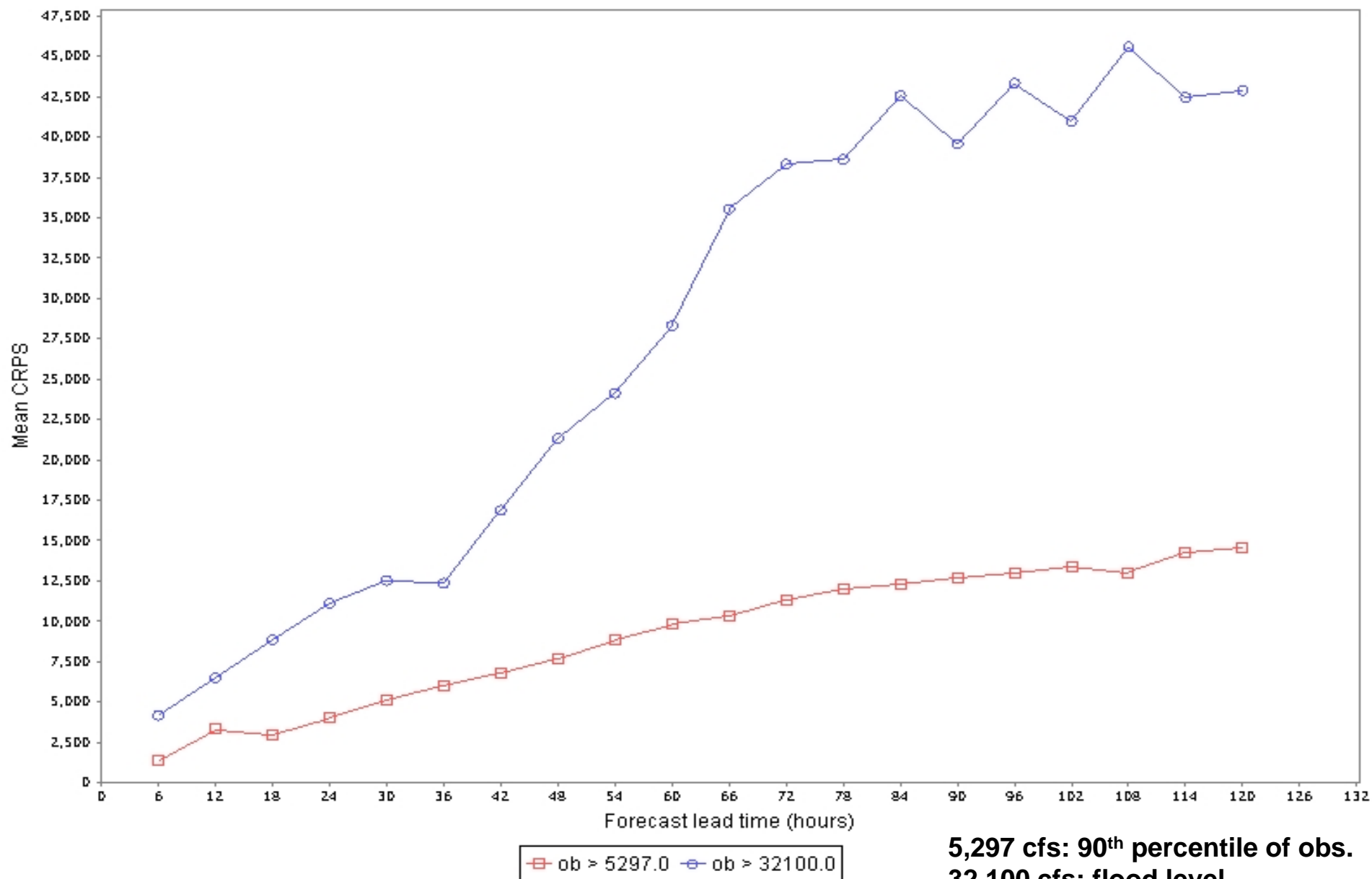


MCRPS for HMOS Ensembles



MCRPS (= MAE) for HMOS Ensb Means

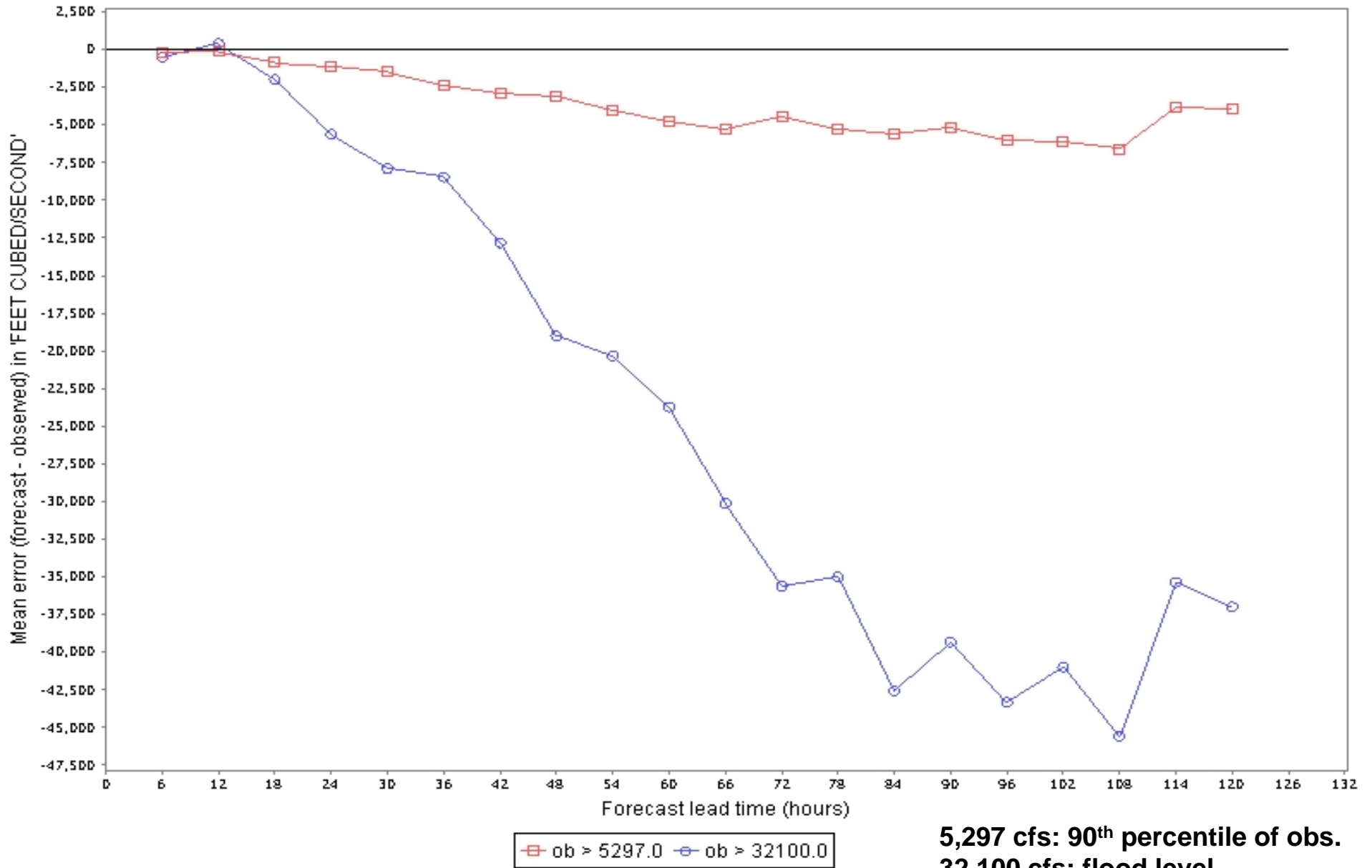
Mean Continuous Ranked Probability Score (CRPS) by forecast lead time.
QUAO2.6_hour.Streamflow.HMOS_mean



5,297 cfs: 90th percentile of obs.
32,100 cfs: flood level

Mean Error for HMOS Ensb Means

Mean error of the ensemble mean forecast by forecast lead time.
QUAO2.6_hour.Streamflow.HMOS

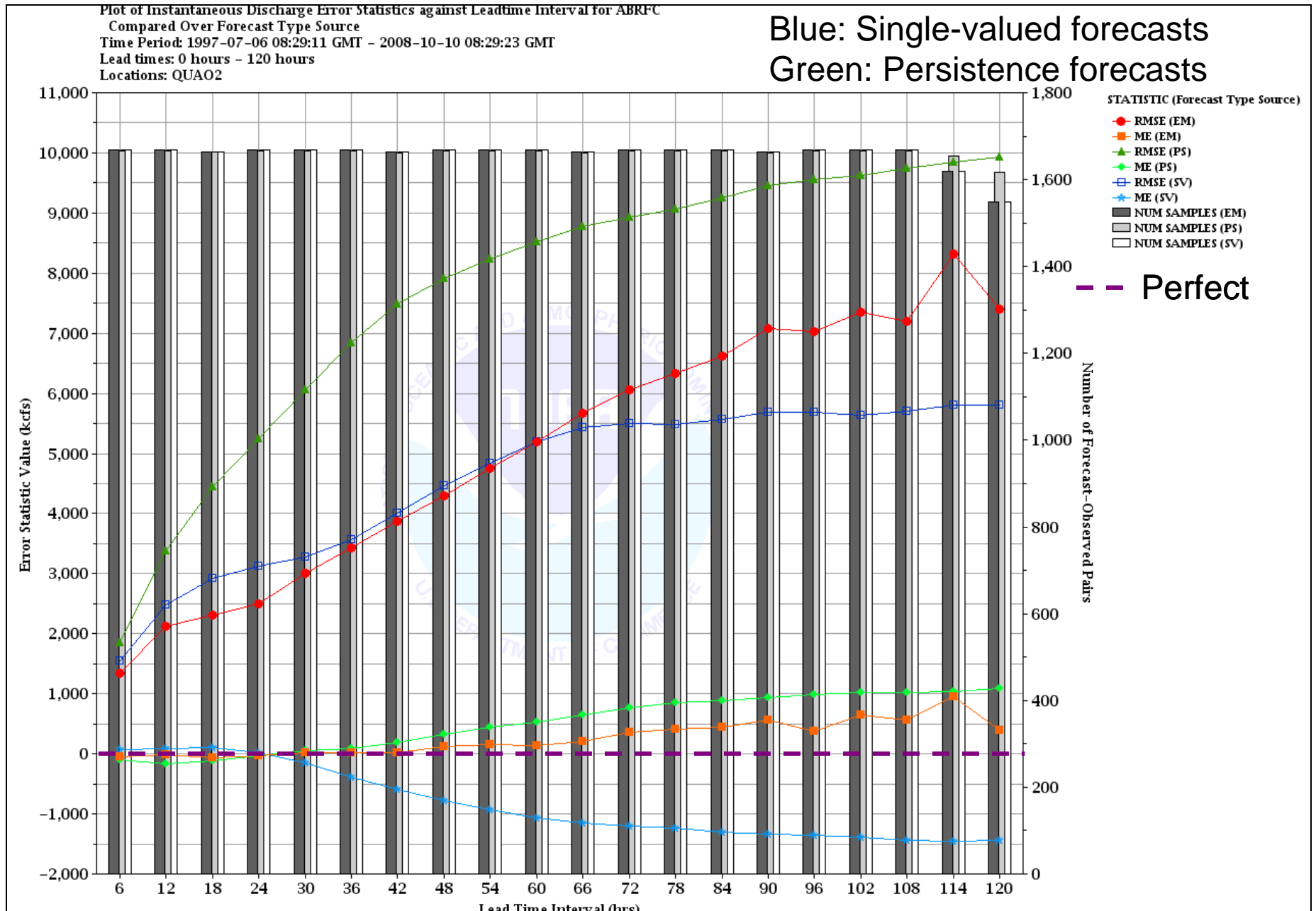


IVP Statistics by lead time – RMSE and ME

Red: HMOS Ensemble Means

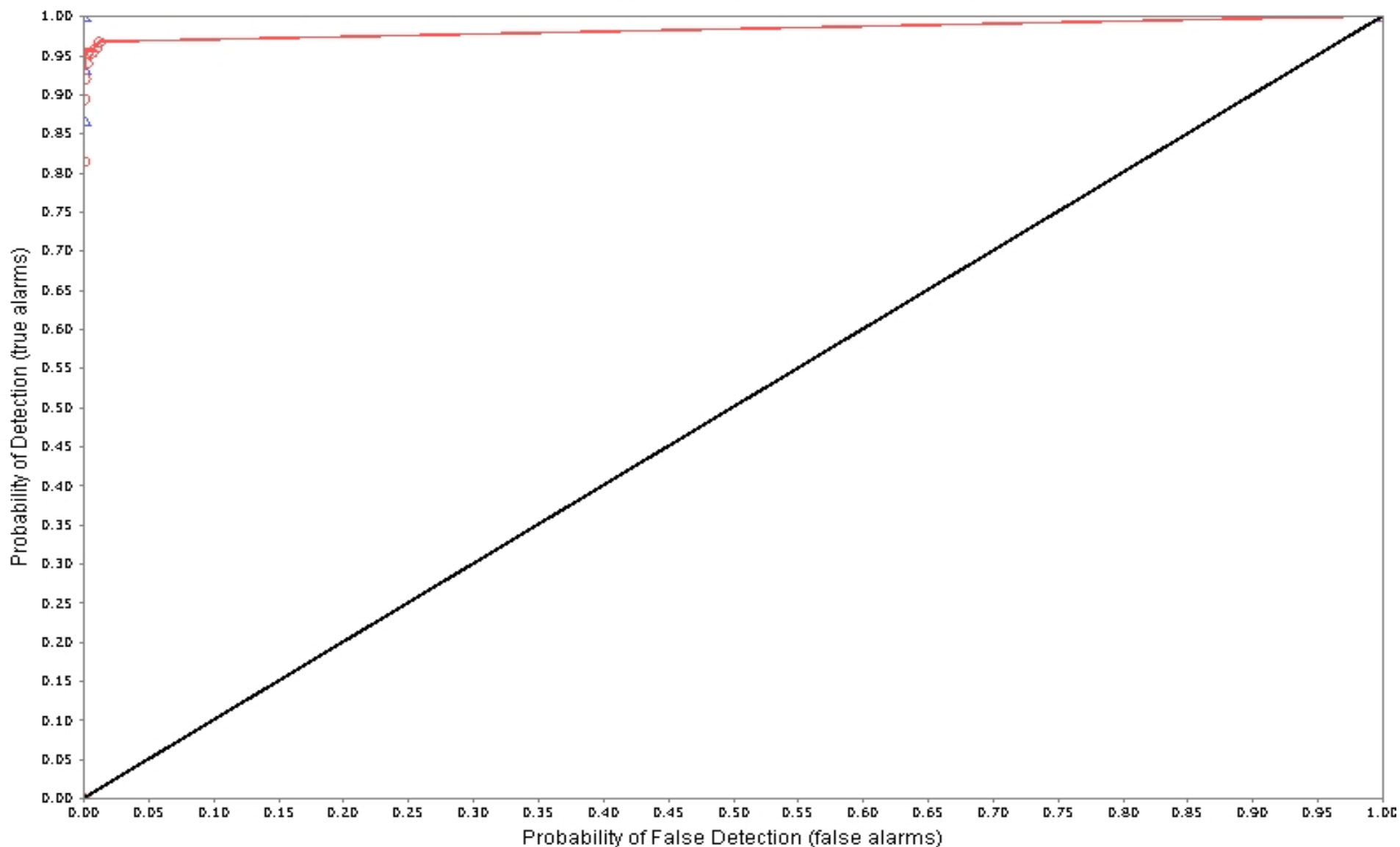
Blue: Single-valued forecasts

Green: Persistence forecasts



ROC for HMOS Ensembles - 6 lead hr

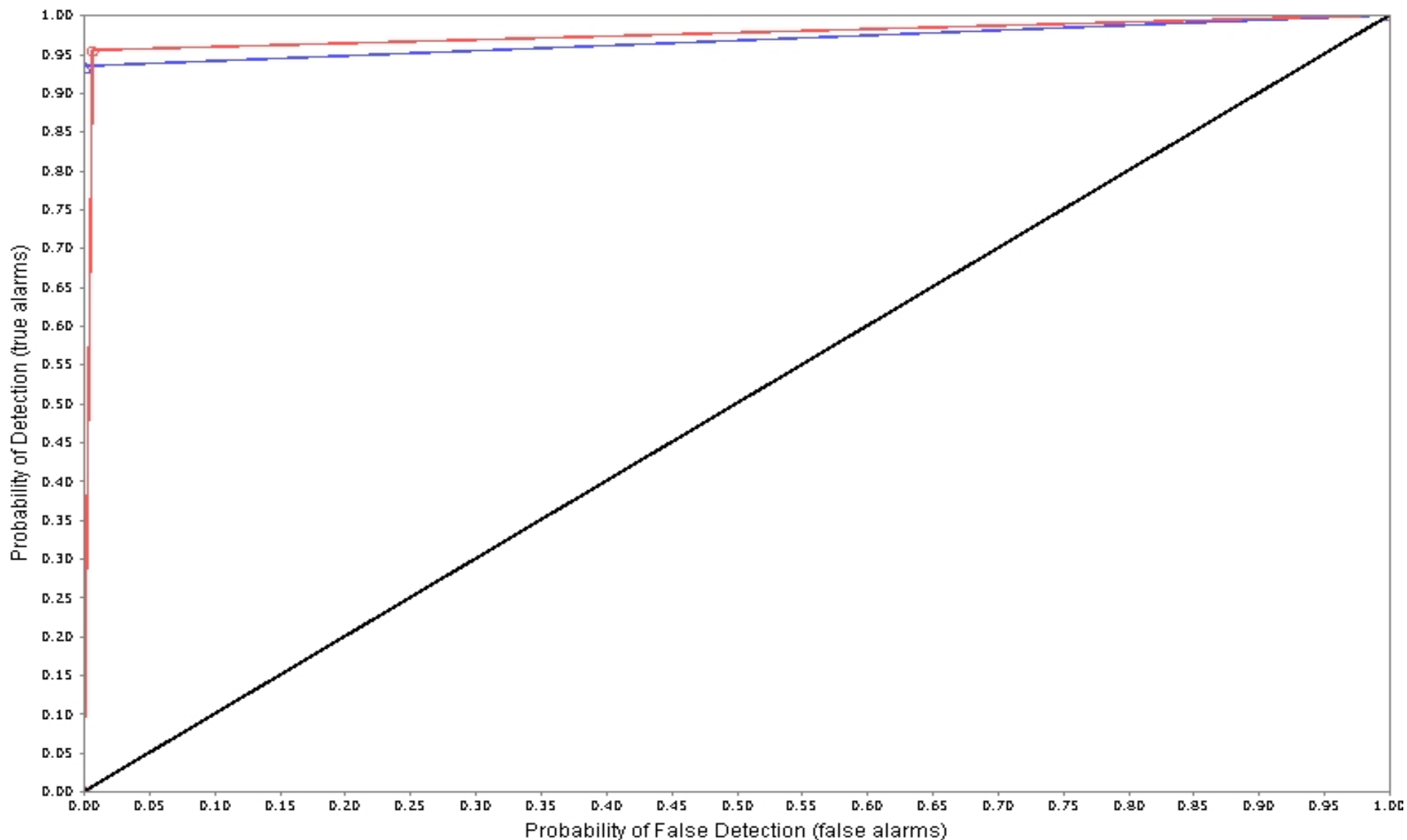
Relative Operating Characteristic for different event (probability) thresholds.
QUAO2.6_hour.Streamflow.HMOS at lead hour 6



5297 cfs: 90th percentile of obs
32100 cfs: flood level

ROC for HMOS Ensb Means - 6 lead hr

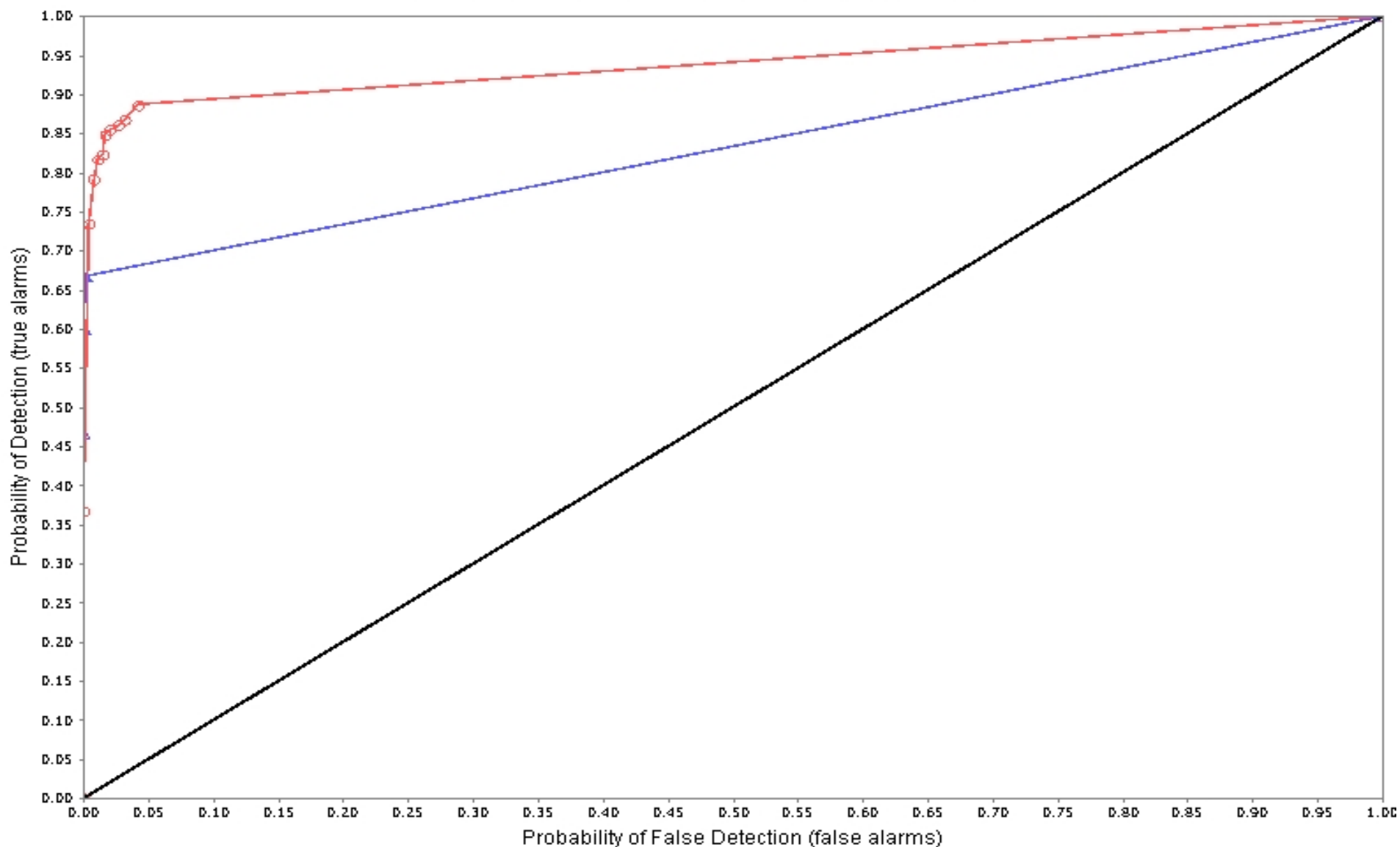
Relative Operating Characteristic for different event (probability) thresholds.
QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 6



5297 cfs: 90th percentile of obs
32100 cfs: flood level

ROC for HMOS Ensembles - 24 lead hr

Relative Operating Characteristic for different event (probability) thresholds.
QUAO2.6_hour.Streamflow.HMOS at lead hour 24

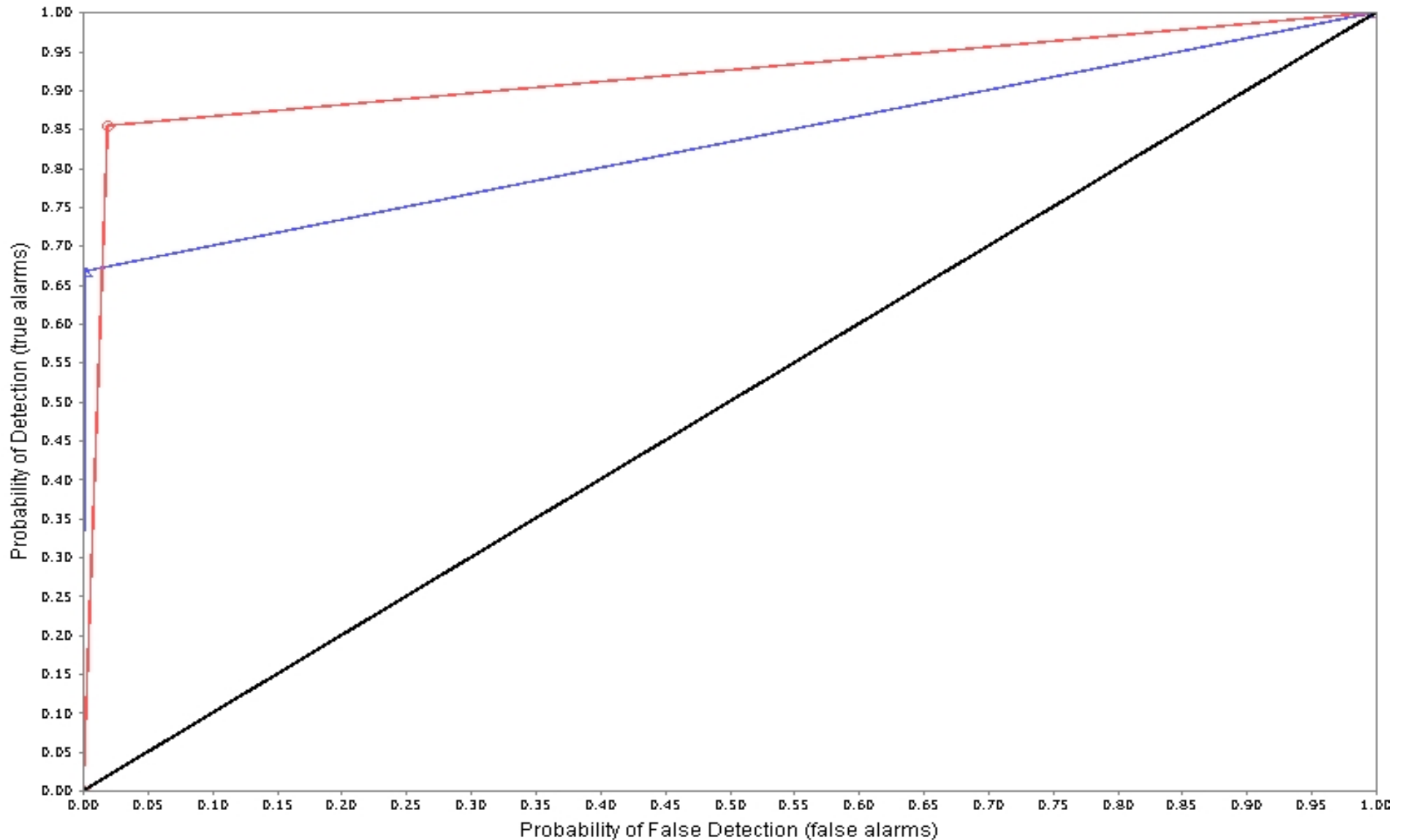


— Random guess (no skill) —○— ob > 5297.0 —△— ob > 32100.0

5297 cfs: 90th percentile of obs
32100 cfs: flood level

ROC for HMOS Ensb Means - 24 lead hr

Relative Operating Characteristic for different event (probability) thresholds.
 QUA02.6_hour.Streamflow.HMOS_mean at lead hour 24

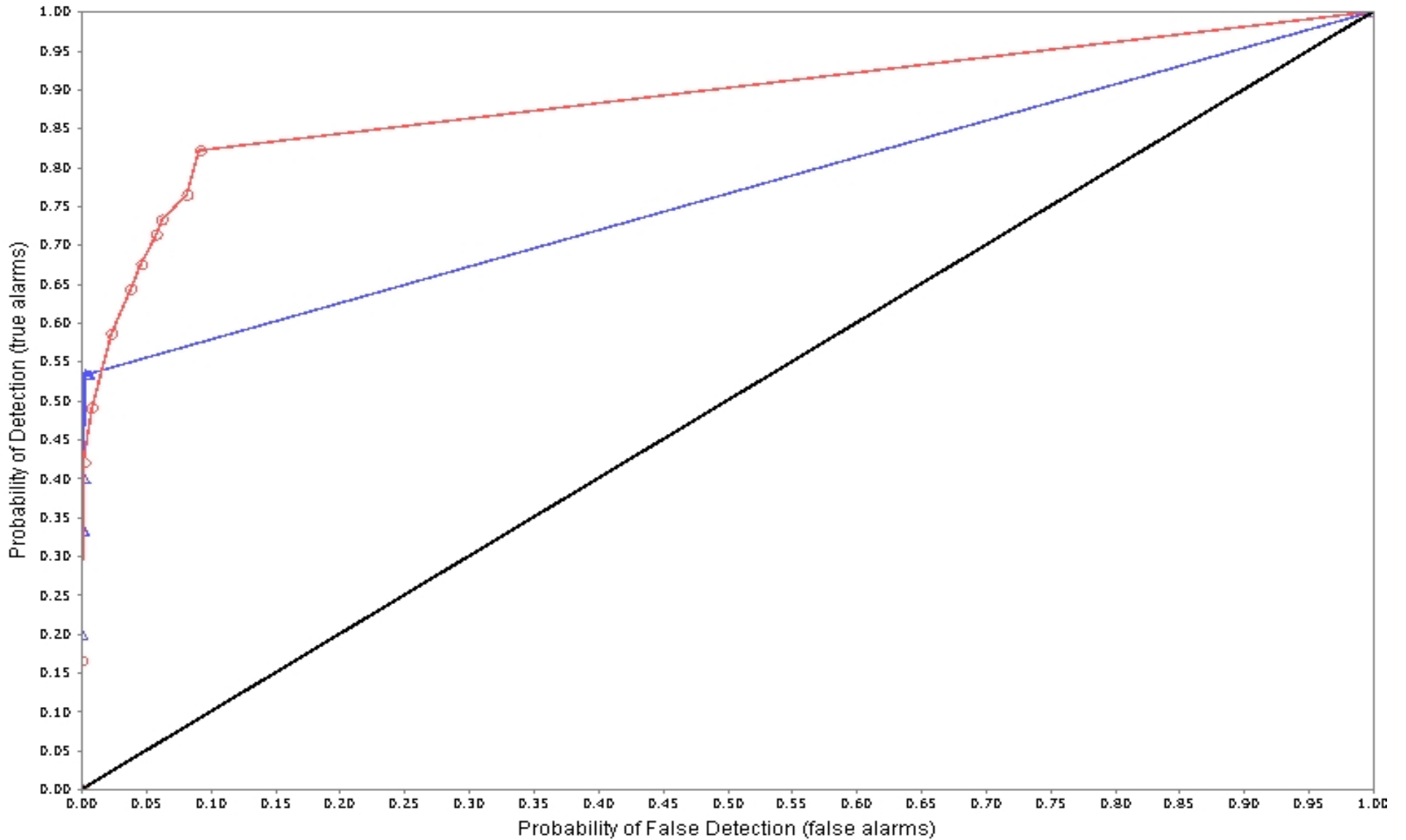


— Random guess (no skill) —○— ob > 5297.0 —△— ob > 32100.0

5297 cfs: 90th percentile of obs
32100 cfs: flood level

ROC for HMOS Ensembles - 48 lead hr

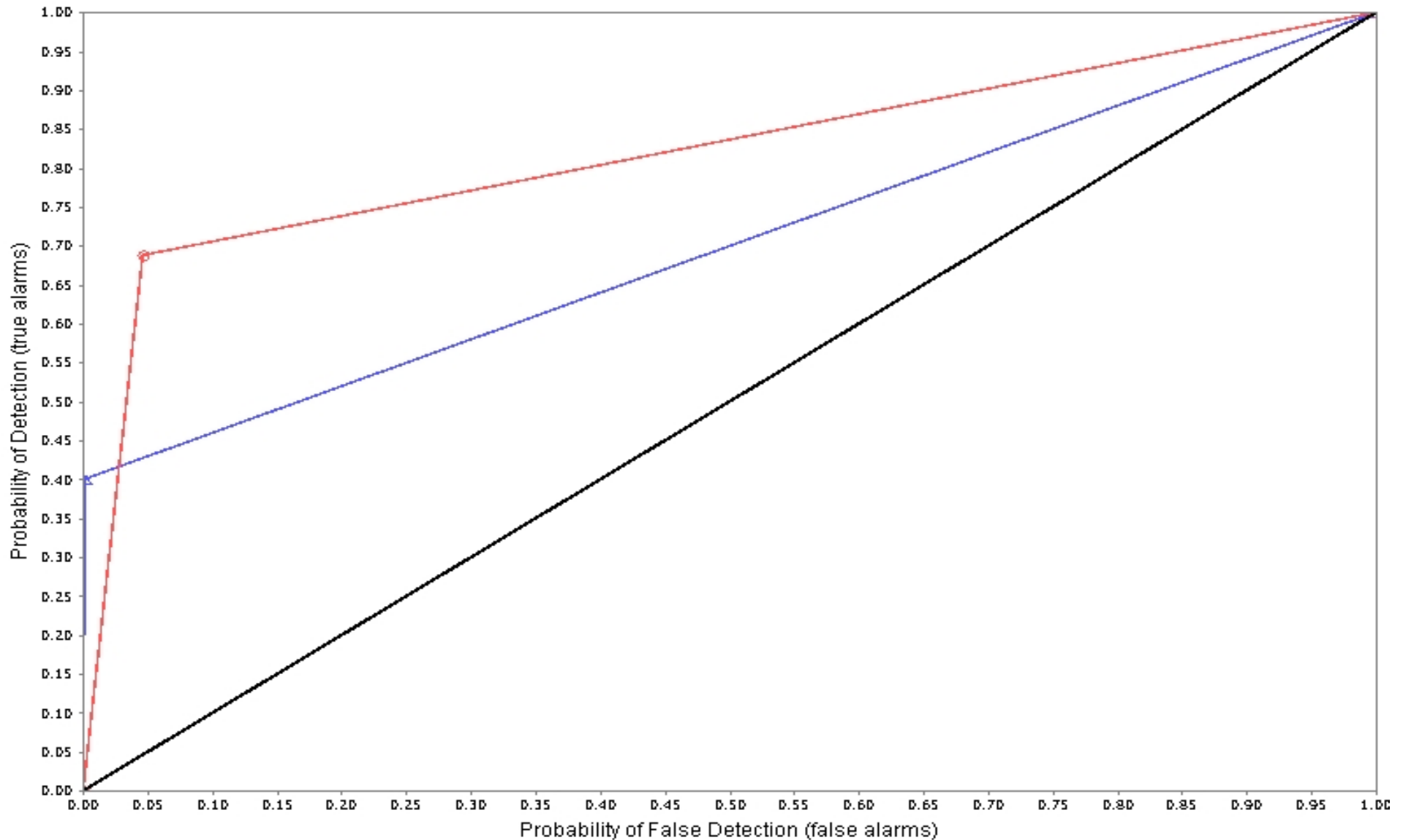
Relative Operating Characteristic for different event (probability) thresholds.
 QUAO2.6_hour.Streamflow.HMOS at lead hour 48



— Random guess (no skill) —○— ob > 5297.0 —△— ob > 32100.0 **5297 cfs: 90th percentile of obs**
32100 cfs: flood level

ROC for HMOS Ensb Means - 48 lead hr

Relative Operating Characteristic for different event (probability) thresholds.
QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 48

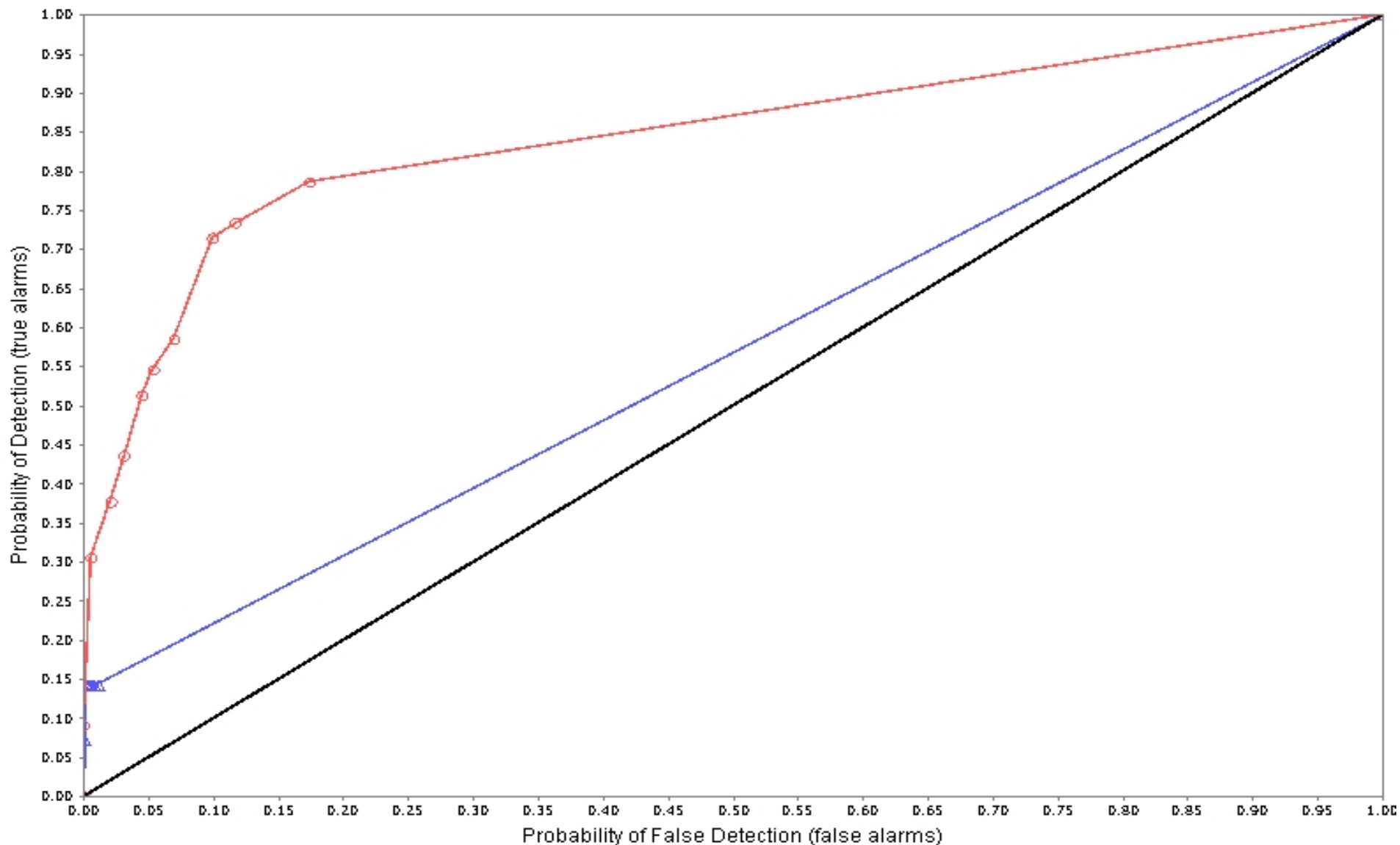


— Random guess (no skill) —○— ob > 5297.0 —△— ob > 32100.0

5297 cfs: 90th percentile of obs
32100 cfs: flood level

ROC for HMOS Ensembles - 72 lead hr

Relative Operating Characteristic for different event (probability) thresholds.
QUAO2.6_hour.Streamflow.HMOS at lead hour 72

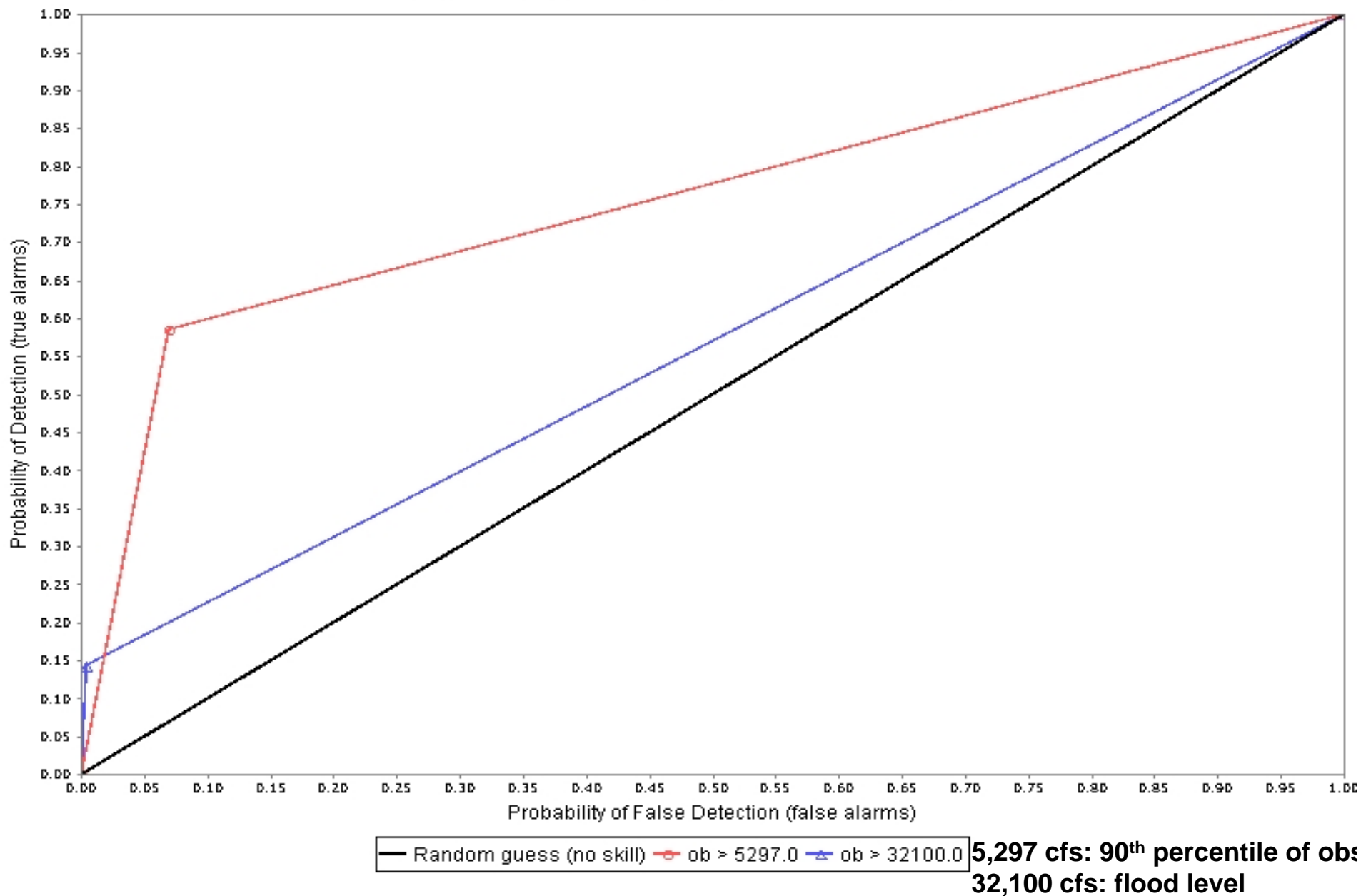


— Random guess (no skill) —○— ob > 5297.0 —△— ob > 32100.0

5297 cfs: 90th percentile of obs
32100 cfs: flood level

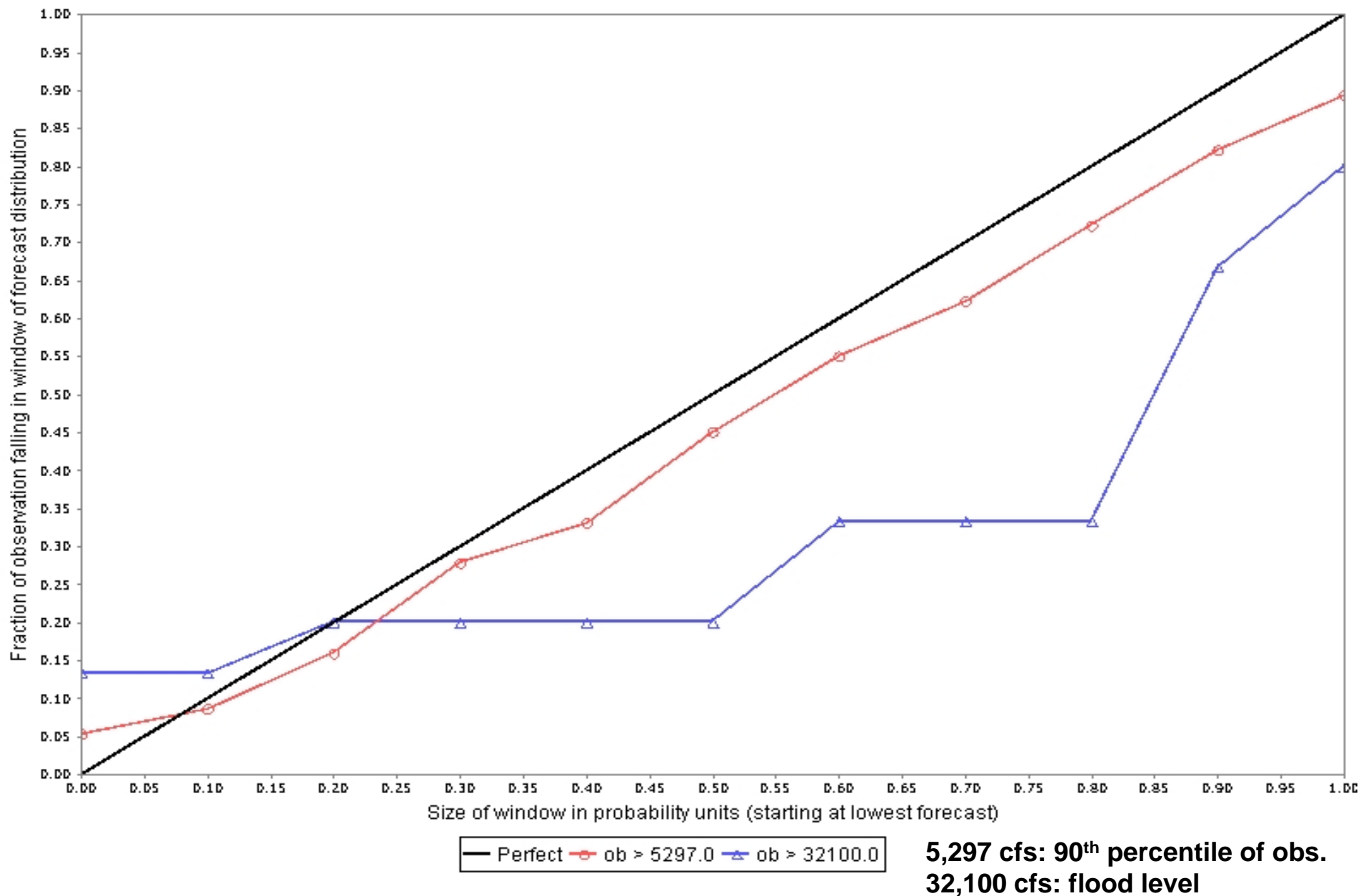
ROC for HMOS Ensb Means - 72 lead hr

Relative Operating Characteristic for different event (probability) thresholds.
QUAO2.6_hour.Streamflow.HMOS_mean at lead hour 72

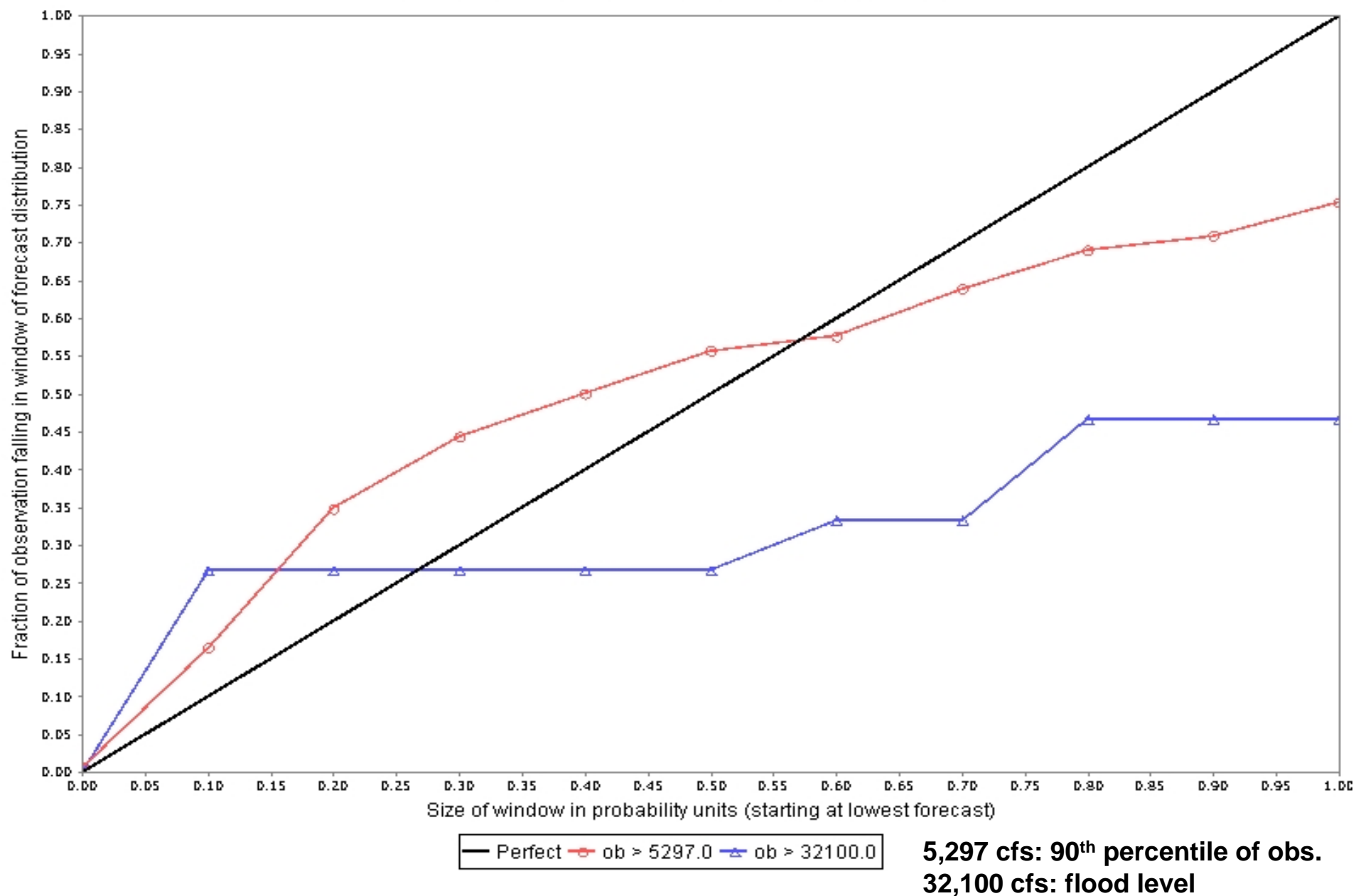


38 Cumulative Talagrand for HMOS Ensembles – 6 lead hr

Cumulative Talagrand plot.
QUAO2.6_hour.Streamflow.HMOS at lead hour 6

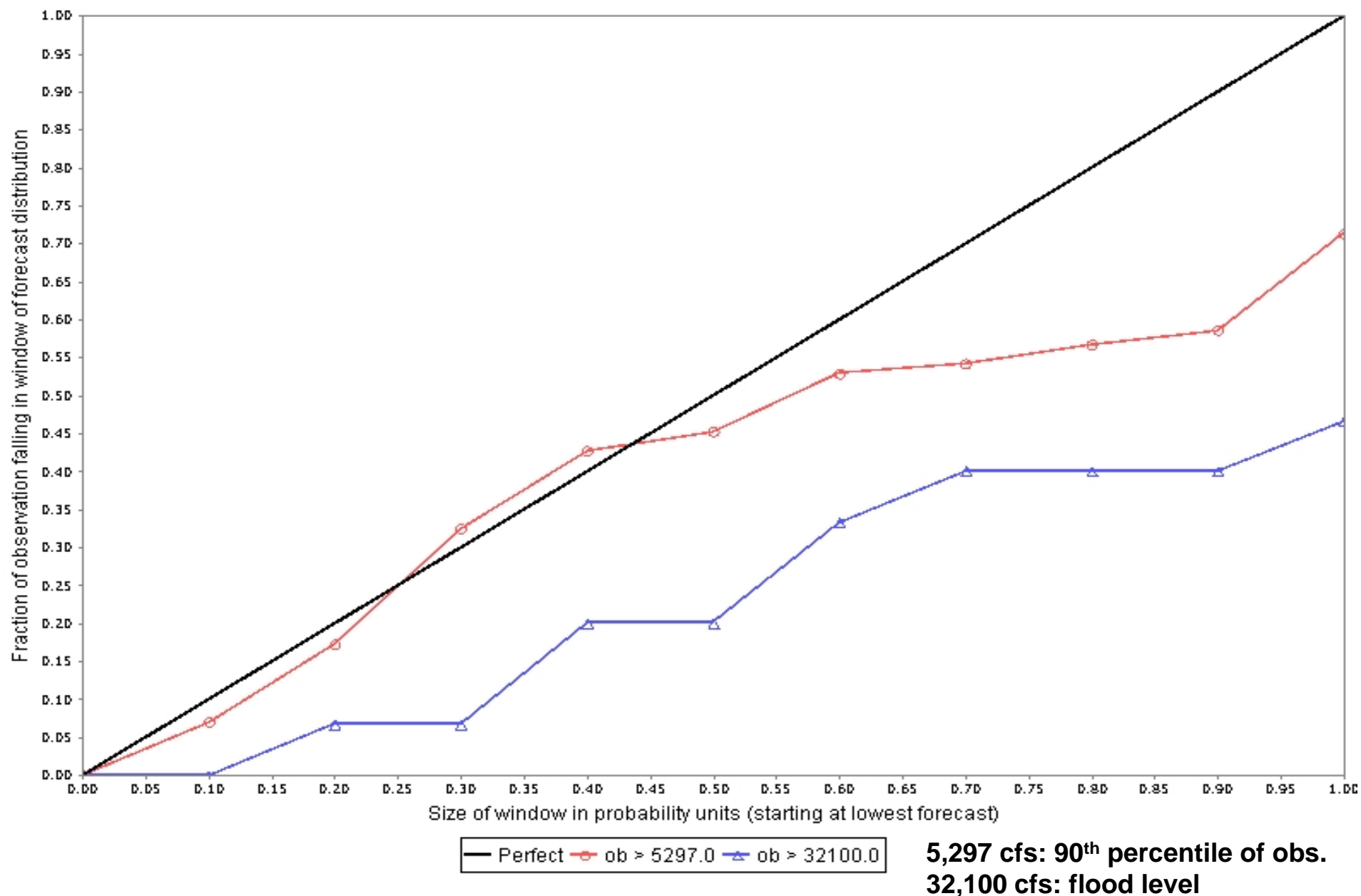


Cumulative Talagrand for HMOS Ensembles – 24 lead hr

Cumulative Talagrand plot.
QUAO2.6_hour.Streamflow.HMOS at lead hour 24

Cumulative Talagrand for HMOS Ensembles – 48 lead hr

Cumulative Talagrand plot.
QUAO2.6_hour.Streamflow.HMOS at lead hour 48



Cumulative Talagrand for HMOS Ensembles – 72 lead hr

Cumulative Talagrand plot.
QUAO2.6_hour.Streamflow.HMOS at lead hour 72

