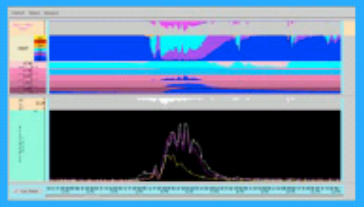
OFS/ESP

CBRFC Forecast Tools
Benefits, Features and Uses

October 18, 2006

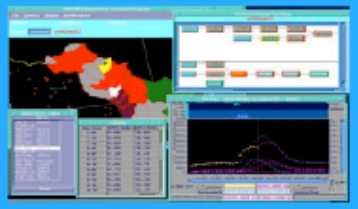
National Weather Service River Forecast System

Three Interconnected Components
Forecasts For Hours To Seasons



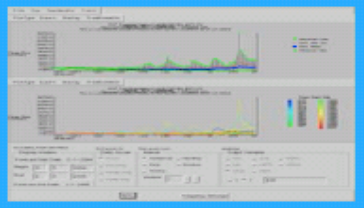
1 Calibration System

Interactive Calibration Program



2 Operational Forecast System

Interactive Forecast Program



3 Ensemble Streamflow Prediction System

ESP Analysis/Display Program

OFS – Operational Forecast System

OFS – Operational Forecast System

Features…

1) Keeps track of model states (1 and 6 hour time steps, depending upon basin) including soil moisture, and snowpack (accumulation and melt)

2) Inputs are precipitation, temperature, and streamflow (which have been quality controlled before input)

3) Keeps track of both routed and local contribtutions to flow

4) Allows input of QPF(5 days), QTF(10 days)

5) Segments viewed, modified through IFP (Interactive Forecast Program)

OFS – Operational Forecast System

Benefits/Uses…

OFS – Operational Forecast System

Benefits/Uses…

1) Supports short range deterministic flow forecasts (hours to 2 weeks)
2) Supports short range contingency forecasting
3) Input/Output and hydrograph viewable at www.cbrfc.noaa.gov

A Collection of Models and Processes

Simulate Snow – Accumulation and Ablation

Compute Runoff Using Soil Moisture Models

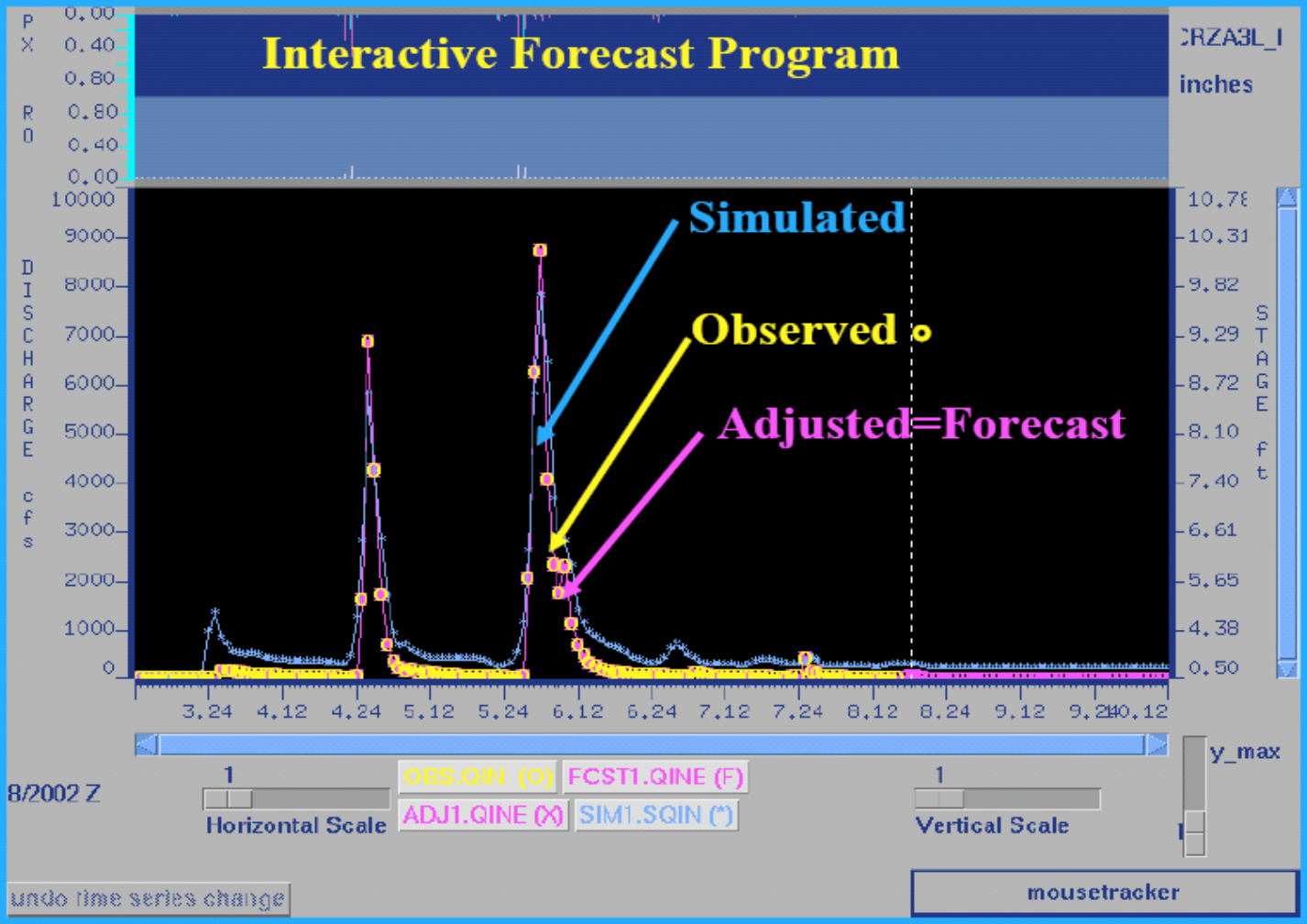
Distribute Runoff In Basin

Route From Basin and Through Channel

Reservoir Operations

Data Management

Example Display From NWSRFS-



CBRFC Main > River > Station

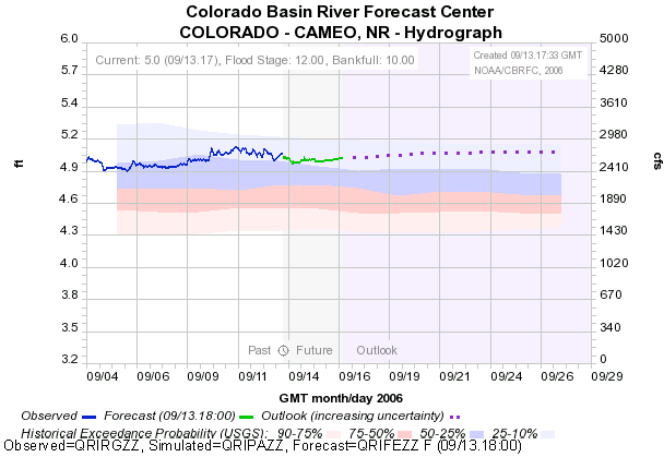
COLORADO - CAMEO, NR (CAMC2)

Hydrologic Services Program User Survey

The NWS Hydrologic Services Program is conducting a survey to determine user satisfaction with its hydrologic services. We would appreciate your feedback by completing the survey administered by CFI Group, a third party research and consulting firm. You can access the survey at http://www.cfigroup.net/NWSSurvey3

Forecasts on this web page are not official and should be used only as guidance.
Official warnings and forecasts can be found here.

View basin in google maps or google earth



Observed=QRIRGZZ, Simulated=QRIPAZZ, Forecast=QRIFEZZ F (09/13.18:00)

Hydrograph Options

- ☐ Critical Stages
- ☐ Simulated
- ☐ Raw Data
- ☐ Linear Flow
- ☐ Historical Peak
- ☐ Yearly Peaks
- ☐ Daily Maxima
- ☑ Statistics
- ☐ Contingency
- ☐ Adjust
- ☐ Requery
- ☐ Forecasts

Years: 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942

Date: 09/13/06

Past Days: 10

Future Days: 15

ESP: Off

Analog Years: Off

Analog Years Period: Off

Apply and Redisplay

Graphs

- ☐ Precipitation
- ☐ Temperature
- ☐ Freezing Level
- ☐ Snow
- ☐ Soil Moisture
- ☐ Rating Table
- ☑ Hydrograph

Tabular Data

- ☐ Precipitation
- ☐ Temperature
- ☐ Freezing Level
- ☐ Snow
- ☐ Soil Moisture
- ☐ Rating Table
- ☐ Critical Stages
- ☐ Peaks
- ☐ Flows

Information

- ☐ Gage Info
- ☐ Basin/Location Maps
- ☐ Aerial/Topo 16 mpp
- ☐ Photos

Up/Downstream

-Upstream- Go

The current time is: 09/13.11:33 MDT, 09/13.17:33 GMT.

Conditions Map Location

Raw observed streamflow data from gages operated by the USGS. View USGS data for this site.

Statistics from USGS for 1933 to 2004 .

Adjustment=0.00 ft

ESP – Ensemble Streamflow Prediction

ESP – Ensemble Streamflow Prediction

Features…

1) Uses model states from OFS as starting point and allows inputs of QPF (5 days) and QTF (10 days)

2) Uses past years and statistical distributions to arrive at probabilistic forecasts of future flow (2 weeks through 1 year)

3) Can be pre and post weighted with CPC forecasts

4) Can be run in regulated or unregulated mode

5) Can remove model (calibration) bias

6) Viewable through ESPADP (Ensemble Streamflow Analysis/Display Program)

ESP – Ensemble Streamflow Prediction

ESP – Ensemble Streamflow Prediction

Benefits/Uses…

1) Volume forecasting for water supply (for any period required i.e. April-July or just April or mid April through mid May, etc)

2) Peak flow forecasting (probabilistic forecasts of both peak and date)

3) Number of days to flow going above or falling below a certain value (most useful for headwaters)

4) Scenario mode using post weighting

5) Can look at individual years

Ensemble Streamflow Prediction

Current hydrologic states (from OFS):

River / Res. Levels

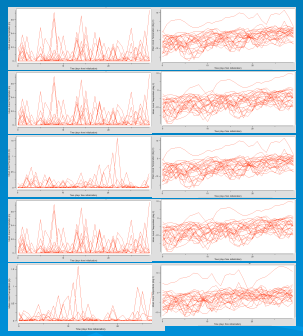
Soil Moisture

Snowpack

Past <-

-> Future Time

71
72
73
74
75



Historical time series of precipitation and temperature (from Calibration).

Ensemble Streamflow Prediction

Current hydrologic states (from OFS):

River / Res. Levels

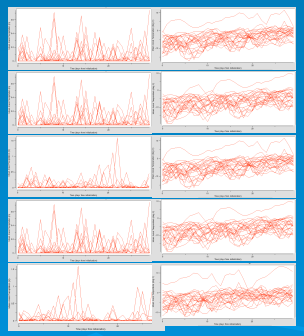
Soil Moisture

Snowpack

Past <-

-> Future Time

71
72
73
74
75



Historical time series of precipitation and temperature (from Calibration).

Start with current conditions – Apply each year of historical climate – Create several possible future streamflow patterns

Ensemble Streamflow Prediction

Current hydrologic states (from OFS):

River / Res. Levels

Soil Moisture

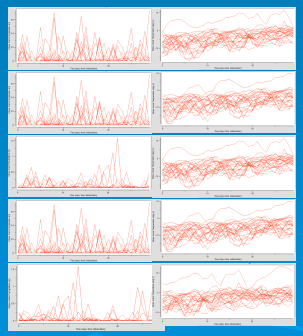
Snowpack

1971

Past <-

-> Future Time

71
72
73
74
75



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Start with current conditions – Apply each year of historical climate – Create several possible future streamflow patterns

Ensemble Streamflow Prediction

Current hydrologic states (from OFS):

River / Res. Levels

Soil Moisture

Snowpack

1971

1972

Past <-

-> Future Time

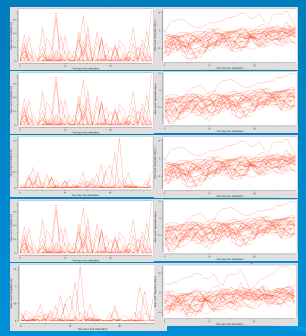
71

72

73

74

75



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Start with current conditions – Apply each year of historical climate – Create several possible future streamflow patterns

Ensemble Streamflow Prediction

Current hydrologic states (from OFS):

River / Res. Levels

Soil Moisture

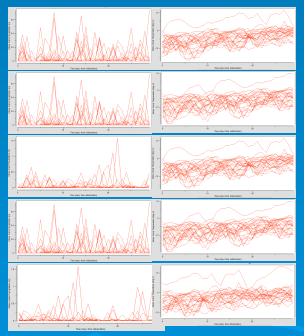
Snowpack

1971
1972
1973

Past <-

-> Future Time

71
72
73
74
75



Historical time series of precipitation and temperature (from Calibration).

Start with current conditions – Apply each year of historical climate – Create several possible future streamflow patterns

Ensemble Streamflow Prediction

Current hydrologic states (from OFS):

River / Res. Levels

Soil Moisture

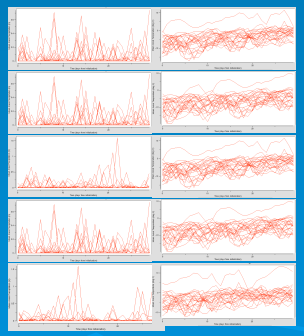
Snowpack

1971
1972
1973
1974

Past <-

-> Future Time

71
72
73
74
75



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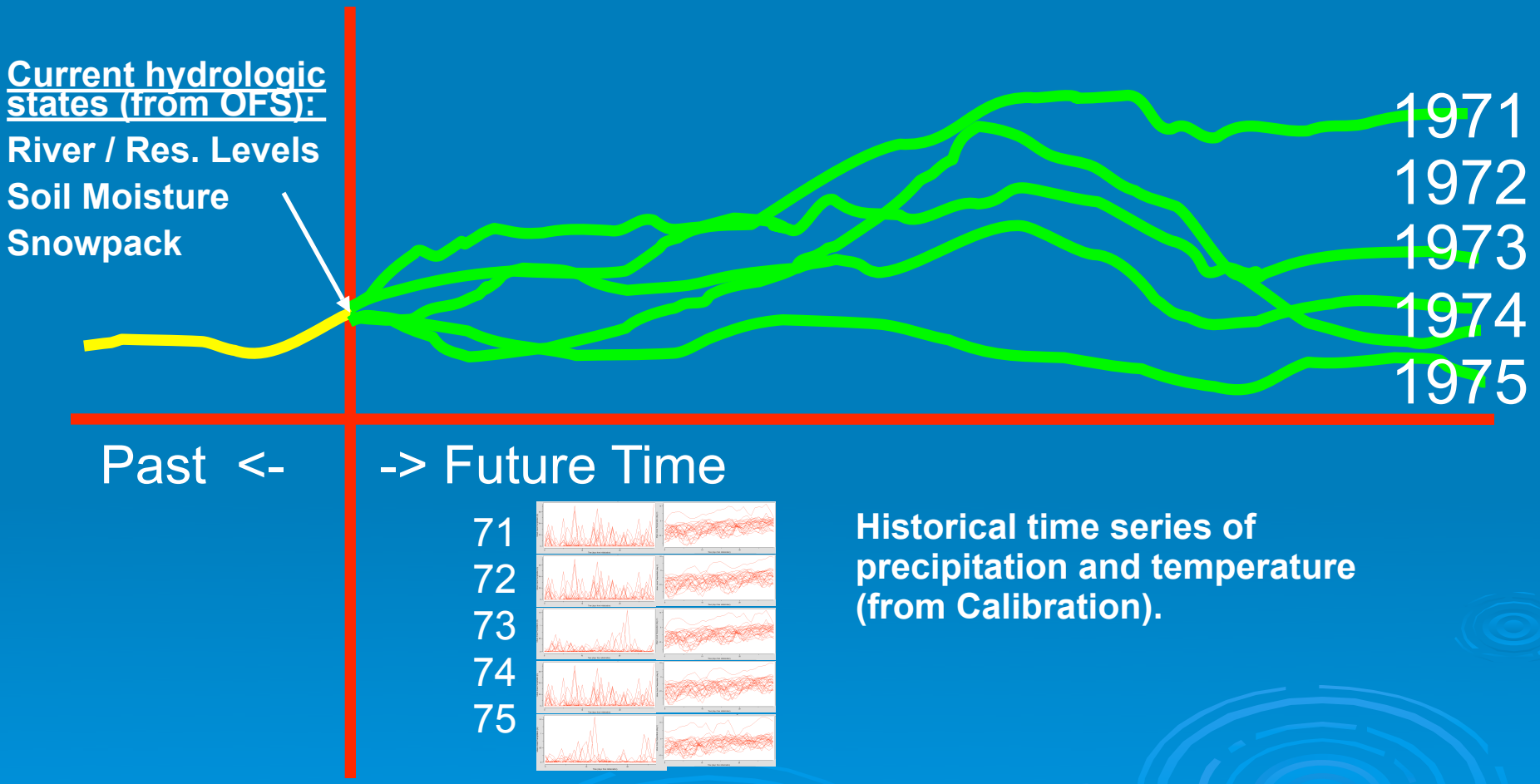


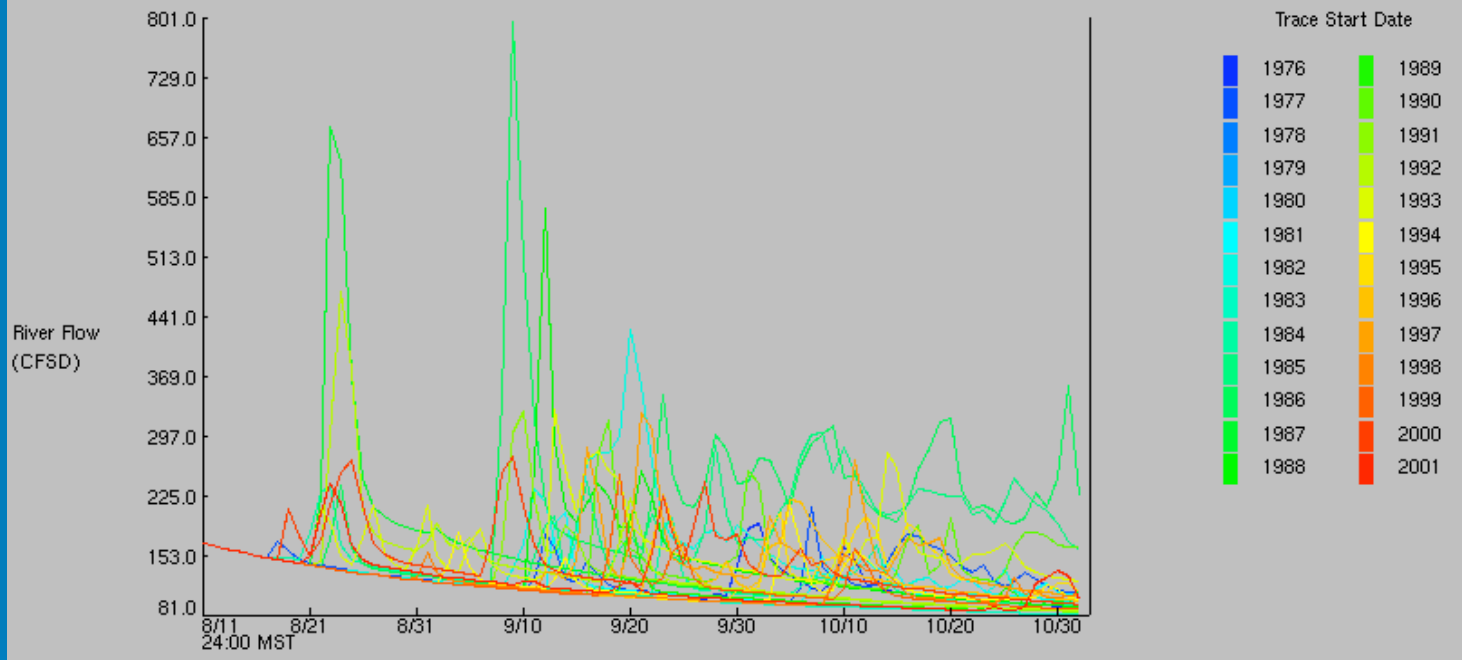
Historical time series of precipitation and temperature (from Calibration).

Start with current conditions – Apply each year of historical climate – Create several possible future streamflow patterns

File View YearWeights Y-axis

PlotType Export Display TraceEnsemble

ESP Trace Ensemble of EAST - ALMONT
Latitude: 38.7 Longitude: 106.8
Forecast for the period 8/11/2006 24h - 11/1/2006 24h
This is a conditional simulation based on the current conditions as of 8/11/2006



9/16@24:00, 665.73

ACCUMULATION SETTINGS

first accum to: *then accum over:* *analyzing:*

Display Window
Forecast Start Date: 8-11-2006
Begin 8 11 2006
End 11 1 2006
Forecast End Date: 11-1-2006

Daily Accum
None
Incl daily
Mean daily
Total daily

Interval
TSInterval Monthly
Daily Window
Weekly
Multiple 1

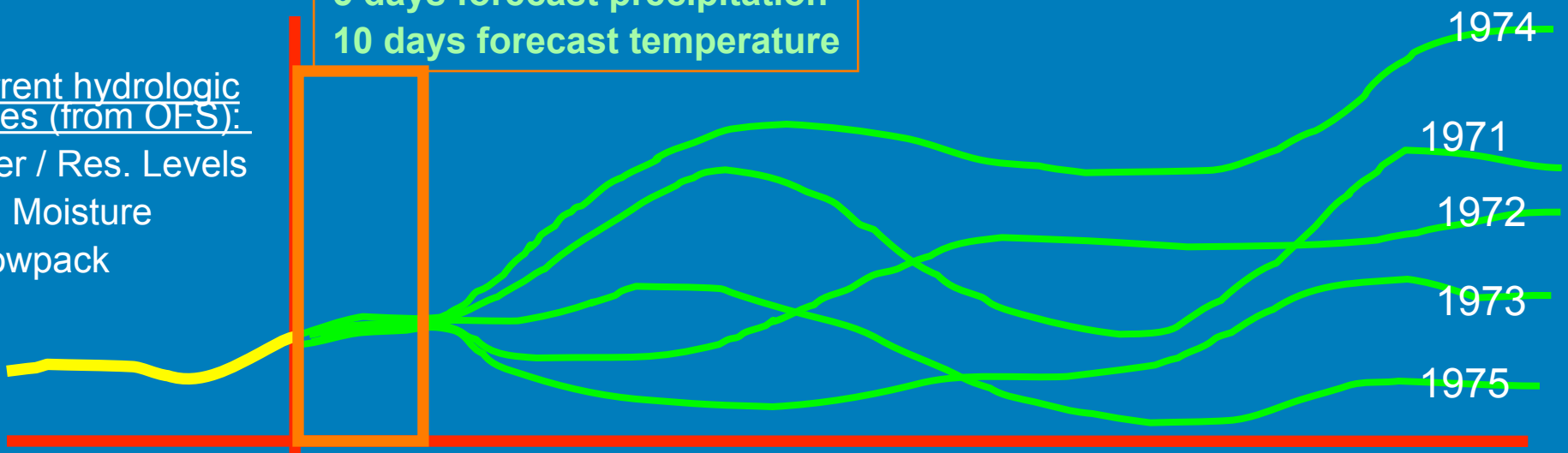
Output Variable
Max Sum NDMX
Min NDTC NDMN
Mean NDIS
< > 0.00

Apply Frequency Settings

Ensemble Streamflow Prediction

5 days forecast precipitation
10 days forecast temperature

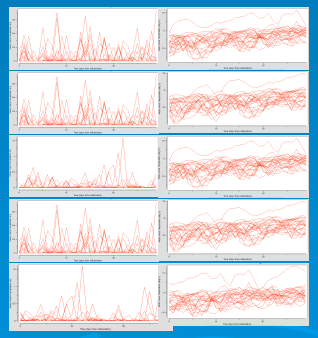
Current hydrologic states (from OFS):
River / Res. Levels
Soil Moisture
Snowpack



Past <-

-> Future Time

71
72
73
74
75



Historical time series of precipitation and temperature (from Calibration).

File View YearWeights Y-axis

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Latitude: 38.7 Longitude: 106.8
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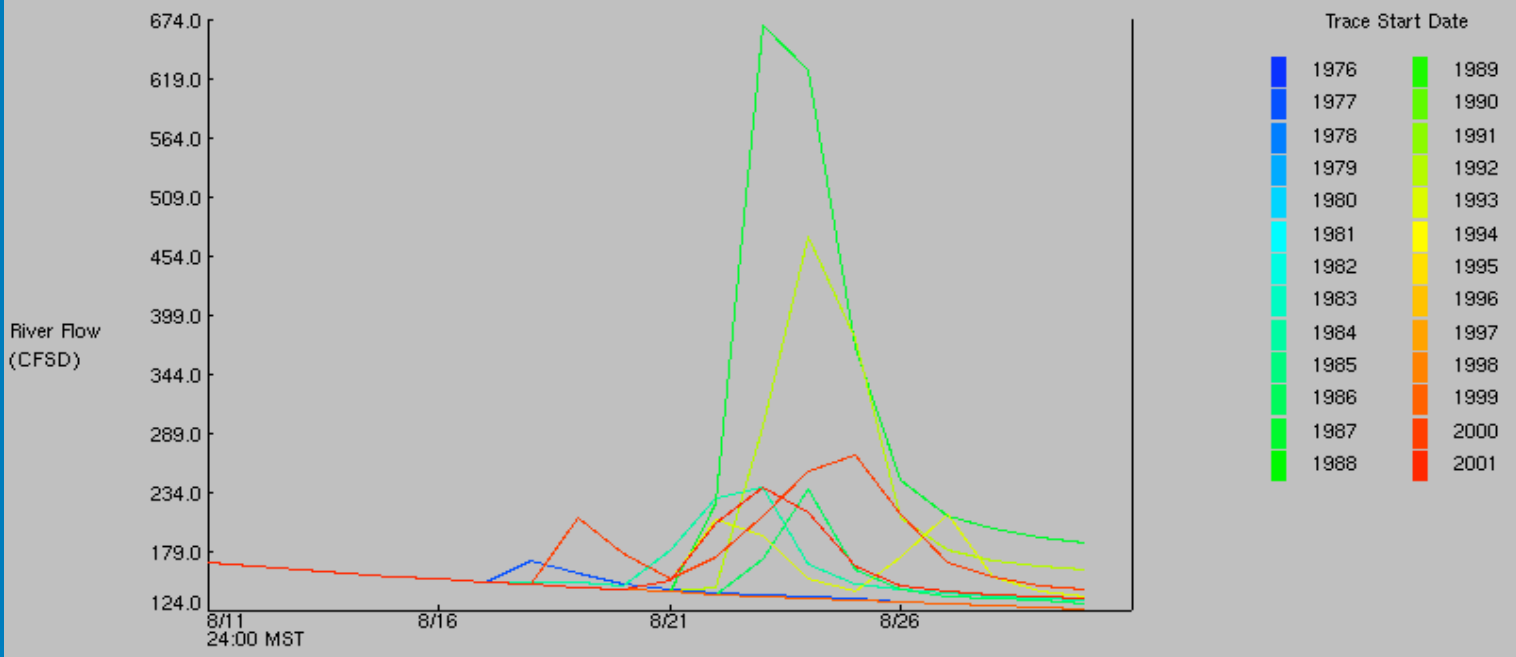

ACCUMULATION SETTINGS

first accum to: *then accum over:* *analyzing:*

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Forecast Start Date: 8-11-2006
Begin 8 11 2006
End 8 30 2006
Forecast End Date: 11-1-2006

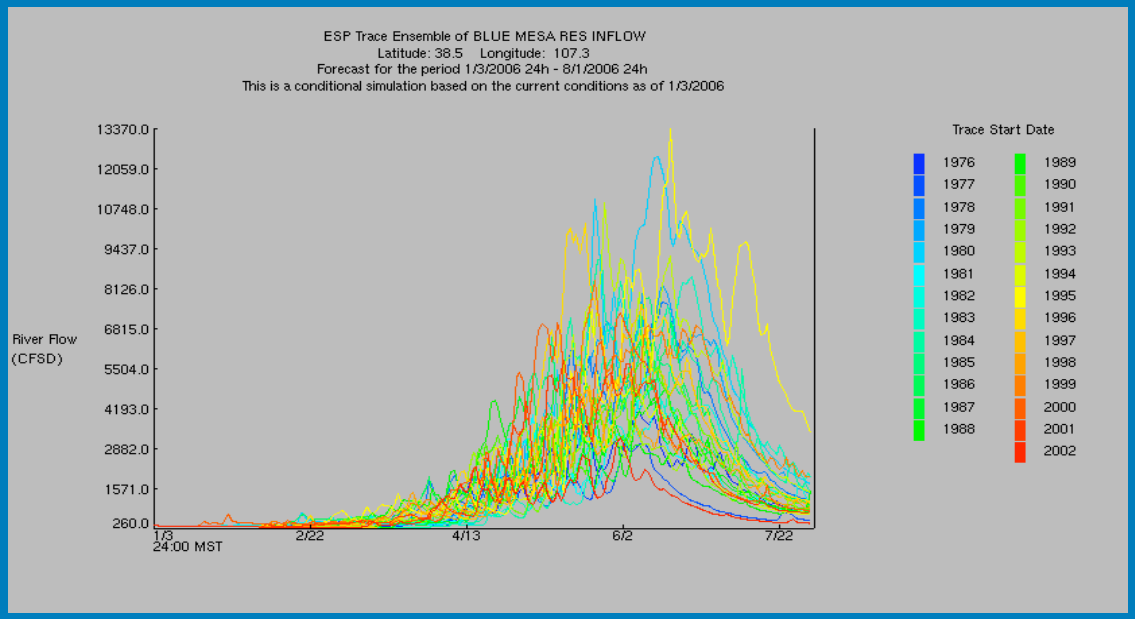
Daily Accum
None
Incl daily
Mean daily
Total daily

Interval
TSInterval Monthly
Daily Window
Weekly
Multiple 1

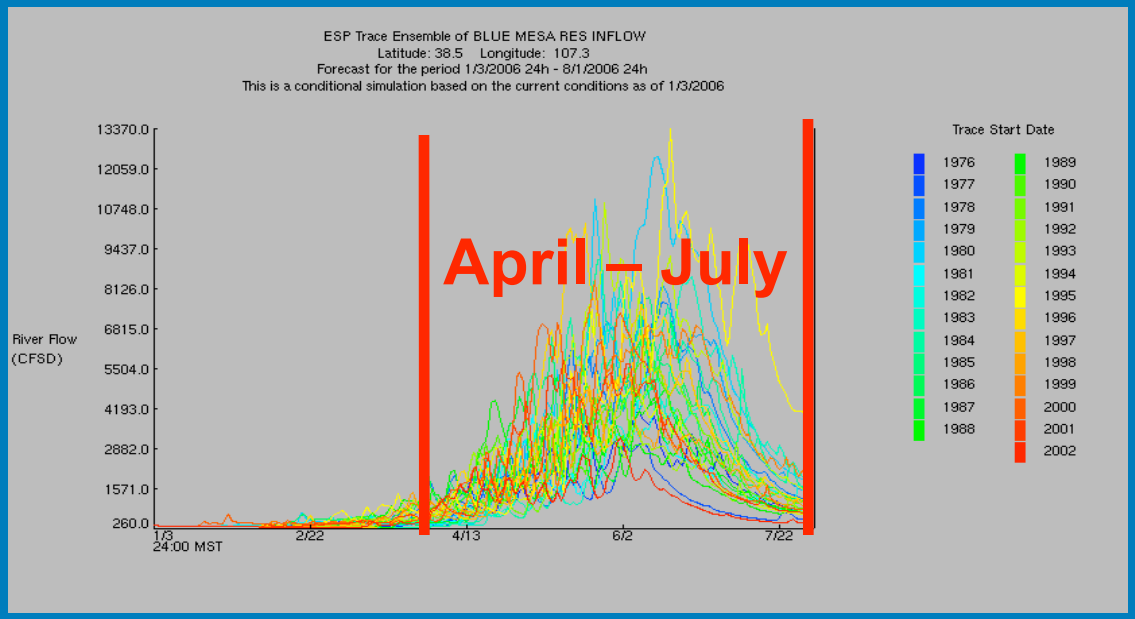
Output Variable
Max Sum NDMX
Min NDTC NDMN
Mean NDIS
< > 0.00

Apply Frequency Settings

Ensemble Streamflow Prediction

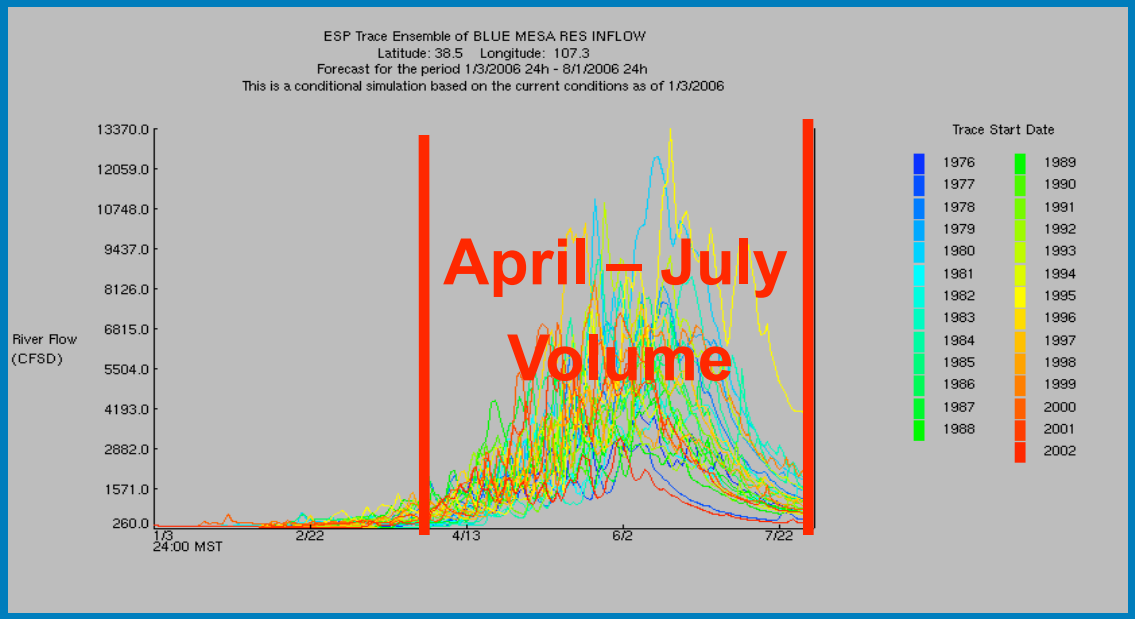


Ensemble Streamflow Prediction



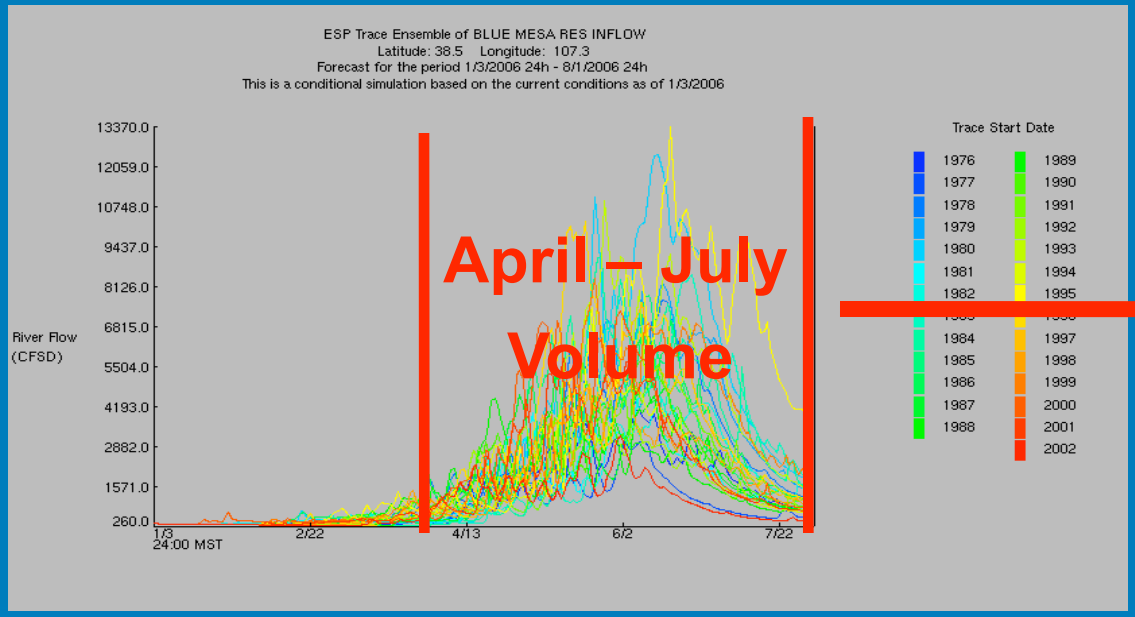
1. Select a forecast window

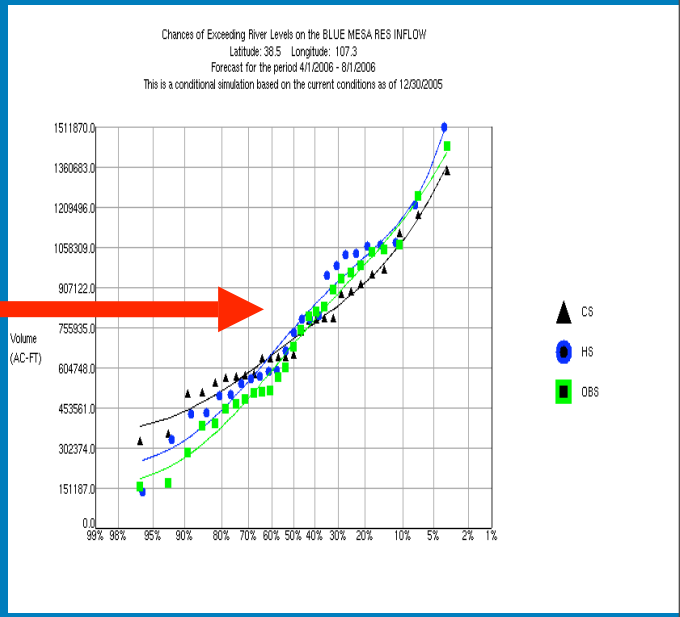
Ensemble Streamflow Prediction



1. Select a forecast window
2. Select a forecast variable

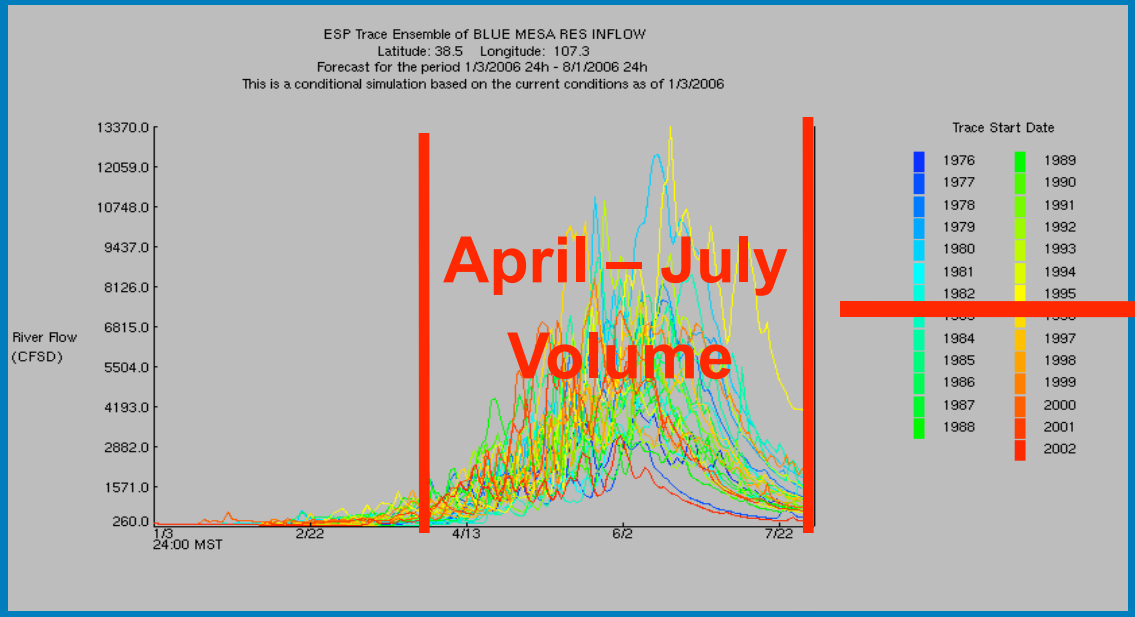
Ensemble Streamflow Prediction

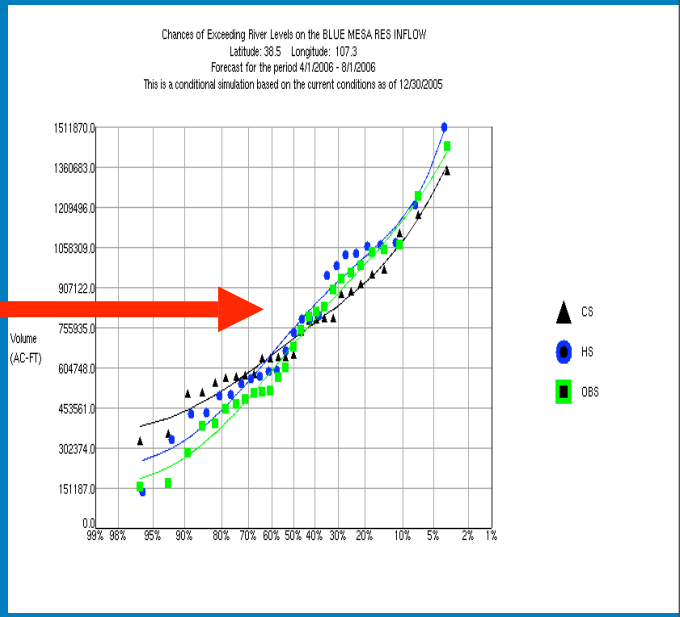




1. Select a forecast window
2. Select a forecast variable
3. Choose a distribution function and display

Ensemble Streamflow Prediction



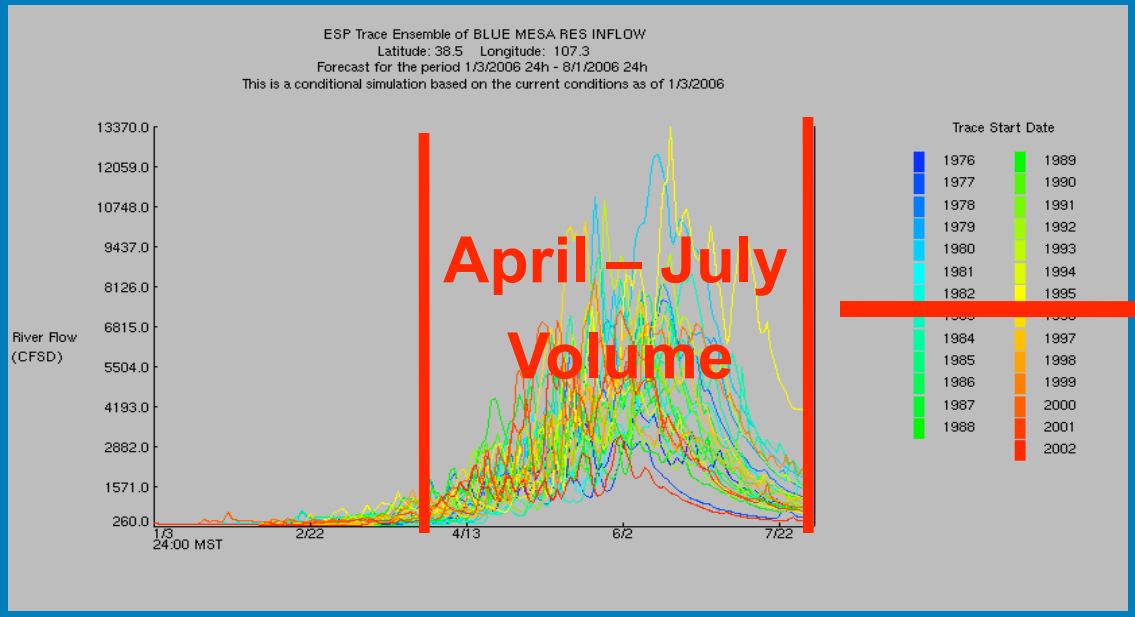


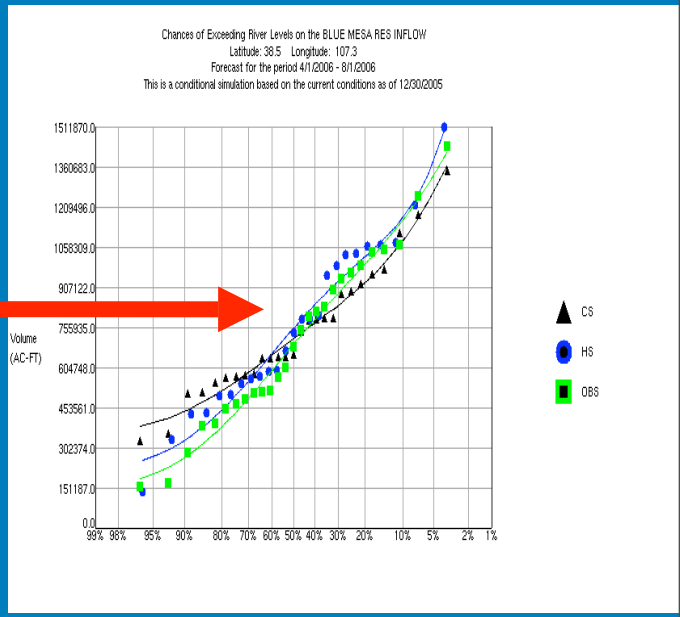
1. Select a forecast window
2. Select a forecast variable
3. Choose a distribution function and display
4. 50% exceedance value = most probable forecast

# Exceedance Probabilities	Conditional Simulation	Historical Simulation	Historical Observed
0.900	438320.500	328520.656	262730.375
0.750	552369.562	499977.531	435810.375
0.500	711742.375	751782.938	691946.625
0.250	877104.812	973699.188	935549.938
0.100	1080490.375	1170393.125	1157333.250

Statistics based on all years.
#

Ensemble Streamflow Prediction





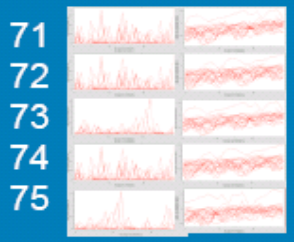
1. Select a forecast window
2. Select a forecast variable
3. Choose a distribution function and display
4. 50% exceedance value = most probable forecast
5. Correct for model bias

# Exceedance Probabilities	Conditional Simulation	Historical Simulation	Historical Observed
0.900	438320.500	328520.656	262730.375
0.750	552369.562	499977.531	435810.375
0.500	711742.375	751782.938	691946.625
0.250	877104.812	973699.188	935549.938
0.100	1080490.375	1170393.125	1157333.250

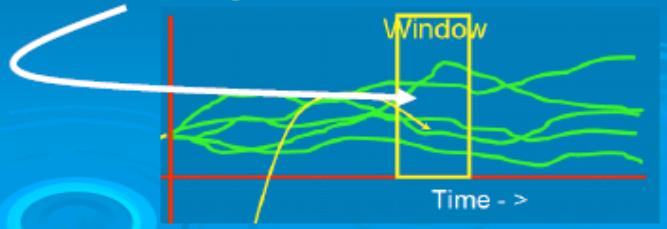
Statistics based on all years.
#

Climate Variability-ESP

Pre -Adjustment Technique
Weight/Modify on Input Side



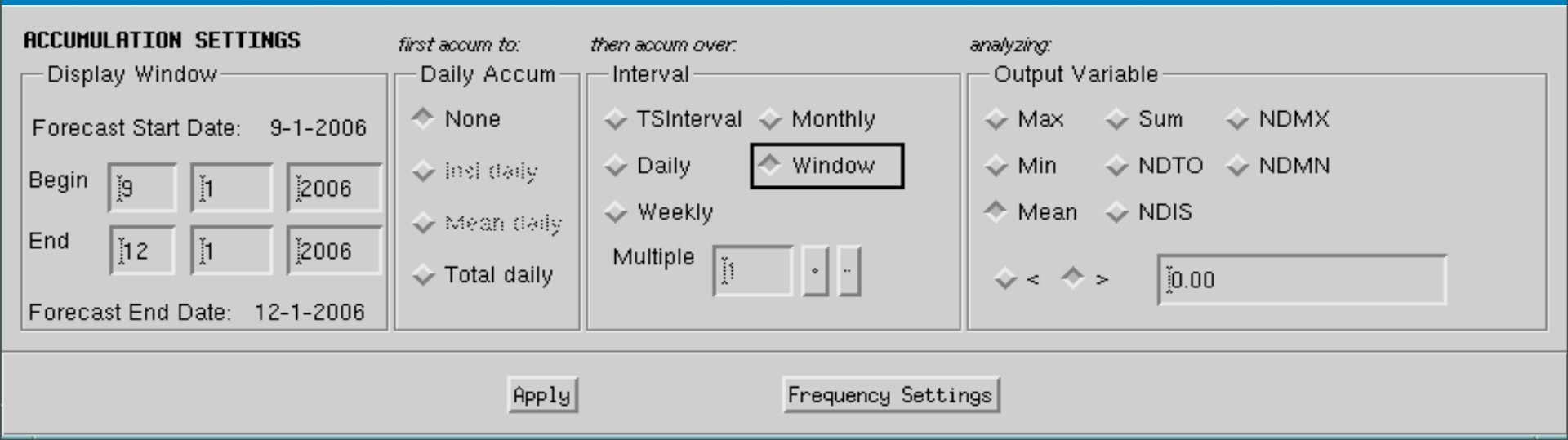
Post -Adjustment Technique
Weight On Output Side



ESPADP Accumulation Settings

Can Create Probabilistic Forecasts for…

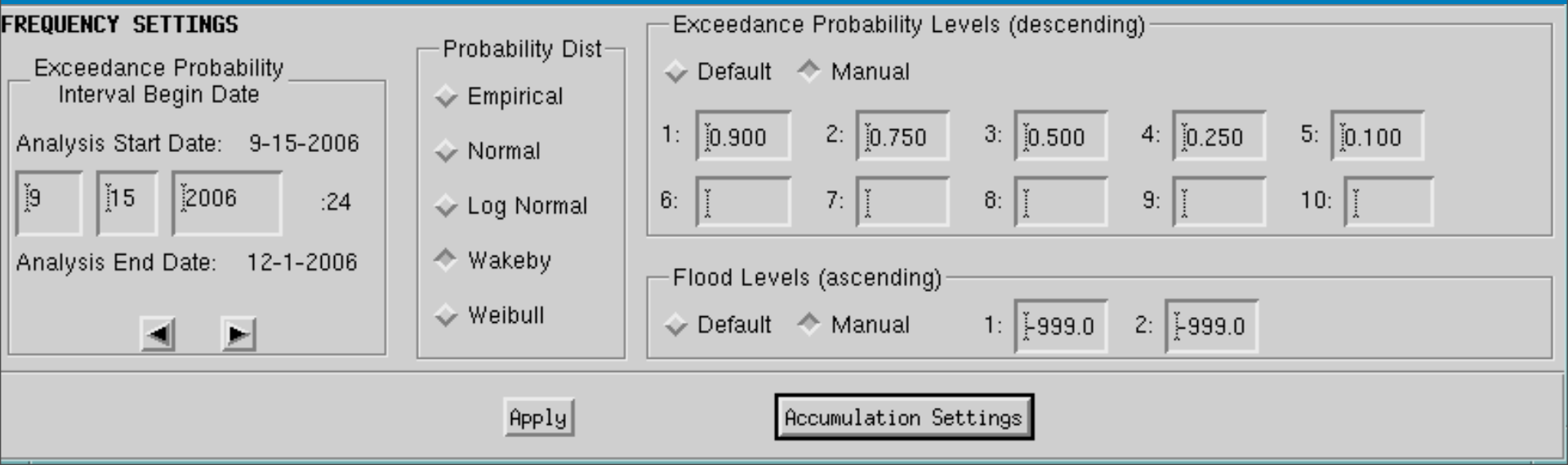
- Max Mean Daily
- Min Mean Daily
- Mean Daily
- Volume (Sum)
- Number of Days to maximum or minimum
- Number of Days to a threshold value (high or low)
- Number of Days in an interval which are above or below a threshold value



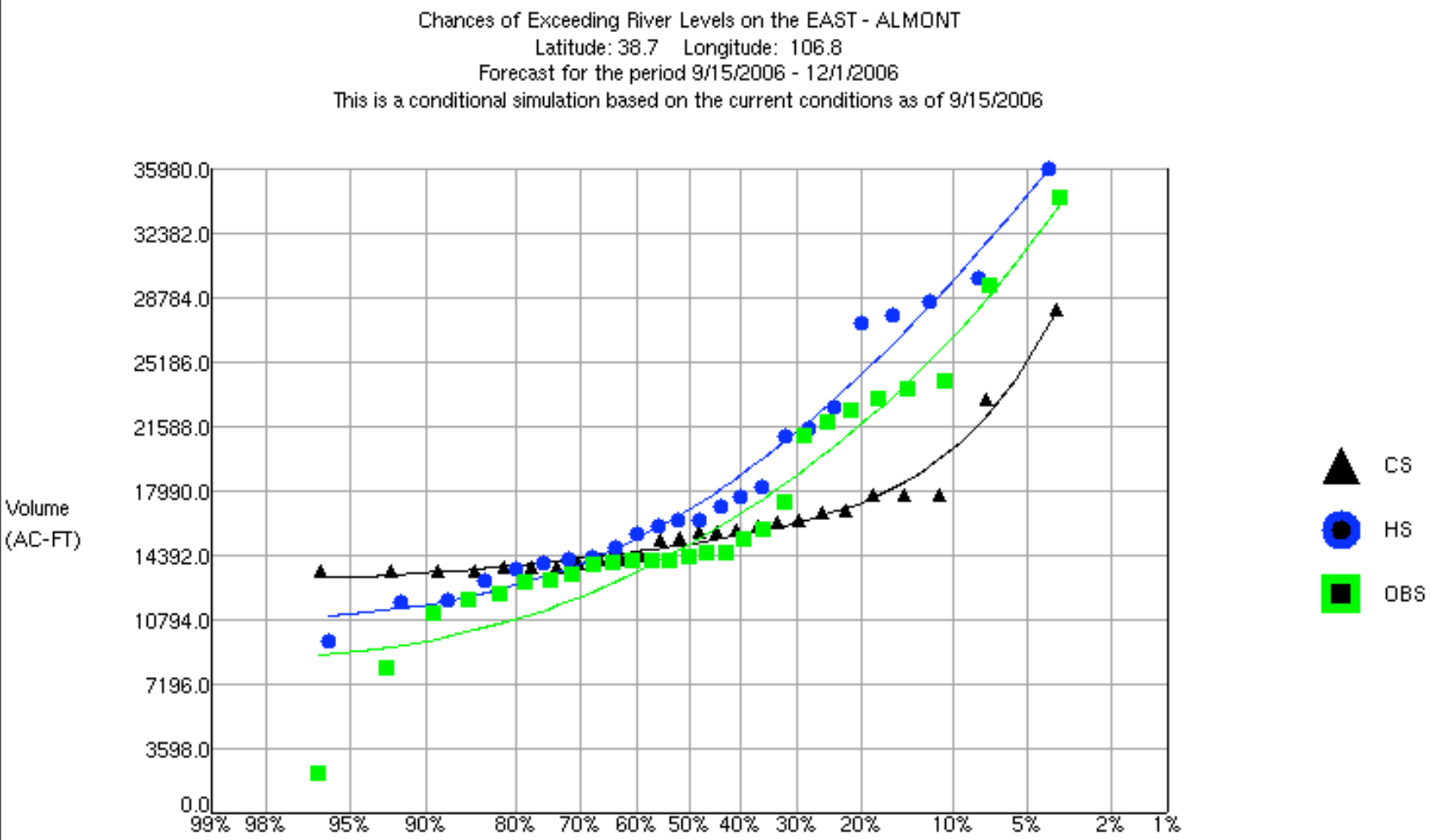
ESPADP Frequency Settings

Can choose Probability Distribution

Can choose Exceedance Probability Levels



Display as Exceedance Probability plot



Quantiles Display

```
# ENSEMBLE HEADER INFORMATION
# Segment: BMDC2L_F
# Trace File Name: BMDC2L_F.SIM24.SQME.24.CS
# Output Variable: Sum
# Data Type: RIVER DISCHARGE
# Units: AC-FT
# Analysis Period: 5/17/2006 24 - 5/15/2007 24 MST
# Interval: 2/1/2007 - 5/15/2007 MST
#
# Statistics based on all years.
#
# EXCEEDANCE PROBABILITY ESTIMATES
#
# Distribution: Wakeby
#      CS: a=0.69 b=1.23 c=1.14 d=0.08 e=-0.42 min=103938.28 max=293416.19
#      HS: a=0.46 b=1.08 c=0.58 d=0.20 e=-0.07 min=105773.91 max=365172.50
#     ER1: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
#     ER2D: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
#     ER2S: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
#     ER3D: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
#     ER3S: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
#     OBS: a=0.39 b=12.04 c=1.52 d=0.15 e=-1.35 min=108112.80 max=378450.78
#    BIAS: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
# Exceedance     Conditional     Historical     Historical
# Probabilities  Simulation      Simulation     Observed
# ------------------------------------------------------------
  0.900          127384.422      134724.500     129883.516
  0.750          153437.688      159555.953     167502.062
  0.500          196325.328      204246.875     196988.641
  0.250          240647.156      260056.156     245596.312
  0.100          274206.094      317220.719     317892.969
#
# EMPIRICAL SAMPLE POINTS
#              Cond.                          Hist.                          Obs.
#Trace    Year       Data Exceed.     Year       Data Exceed.     Year       Data Exceed.
# year  Weight      Point   Prob.  Weight      Point   Prob.  Weight      Point   Prob.
# ------------------------------------------------------------------------------------
   1977   0.038 103938.281   0.963                                0.038 108112.797   0.963
   1978   0.038 209084.516   0.370   0.040 167517.406   0.731    0.038 176614.047   0.667
   1979   0.038 200663.000   0.444   0.040 211960.172   0.500    0.038 196216.094   0.519
   1980   0.038 185902.516   0.593   0.040 220358.641   0.423    0.038 244155.891   0.259
   1981   0.038 130886.078   0.889   0.040 172437.312   0.654    0.038 114318.367   0.889
   1982   0.038 170389.344   0.667   0.040 150321.625   0.846    0.038 195449.094   0.556
   1983   0.038 112977.336   0.926   0.040 124250.781   0.923    0.038 147606.516   0.778
   1984   0.038 154665.922   0.778   0.040 164764.906   0.769    0.038 226440.938   0.333
   1985   0.038 288152.938   0.074   0.040 365172.500   0.038    0.038 378450.781   0.037
   1986   0.038 293416.188   0.037   0.040 333588.750   0.077    0.038 315785.188   0.148
   1987   0.038 273184.312   0.111   0.040 309266.031   0.154    0.038 330646.156   0.074
   1988   0.038 148953.219   0.815   0.040 161203.562   0.808    0.038 144039.781   0.815
   1989   0.038 261376.141   0.185   0.040 247406.188   0.269    0.038 214873.469   0.370
   1990   0.038 178433.031   0.630   0.040 173546.281   0.615    0.038 110576.203   0.926
   1991   0.038 160856.953   0.741   0.040 149201.578   0.885    0.038 190778.031   0.593
   1992   0.038 215531.344   0.333   0.040 216303.000   0.462    0.038 176534.328   0.704
   1993   0.038 203670.375   0.407   0.040 185615.094   0.577    0.038 235848.875   0.296
   1994   0.038 193036.344   0.481   0.040 227831.875   0.346    0.038 200963.625   0.481
   1995   0.038 167128.781   0.704   0.040 167861.781   0.692    0.038 186613.922   0.630
   1996   0.038 272151.469   0.148   0.040 329034.625   0.115    0.038 324065.031   0.111
   1997   0.038 241533.547   0.222   0.040 268262.969   0.192    0.038 294621.875   0.185
   1998   0.038 189531.562   0.556   0.040 221897.266   0.385    0.038 206538.562   0.407
   1999   0.038 192971.828   0.519   0.040 202479.578   0.538    0.038 164292.344   0.741
   2000   0.038 238115.094   0.259   0.040 262579.000   0.231    0.038 270599.000   0.222
   2001   0.038 233328.344   0.296   0.040 230792.516   0.308    0.038 205328.922   0.444
   2002   0.038 141899.656   0.852   0.040 105773.906   0.962    0.038 121493.555   0.852
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Display as Histogram of Exceedance Probabilities