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
OF5 – 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 contributions 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
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/NWSurvey.

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

The current time is: 09/13 11:33 MDT, 09/13 17:33 GMT.

Conditions Map Location
Raw assumed streamflow data from gages operated by the USGS. View USGS data for this site.
Statistics from USGS for 1933 to 2004.
Adjustment for USGS.
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

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

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

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

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

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

Past <-

Future Time ->

1971
1972
1973

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

Past <- Future Time


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

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

Historical time series of precipitation and temperature (from Calibration).
ESP Trace Ensemble of EAST - ALMONT
Latitude: 38.7  Longitude: 106.8
Forecast for the period 6/1/2006 24h - 11/1/2006 24h
This is a conditional simulation based on the current conditions as of 6/11/2006

9/16@24:00, 665.73

ACCUMULATION SETTINGS

<table>
<thead>
<tr>
<th>Display Window</th>
<th>Forecast Start Date: 6-11-2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Begin</td>
<td>[8][11][2006]</td>
</tr>
<tr>
<td>End</td>
<td>[11][1][2006]</td>
</tr>
<tr>
<td>Forecast End Date: 11-1-2006</td>
<td></td>
</tr>
</tbody>
</table>

first accumulate: Daily Accum
- None
- Inst Daily
- Mean Daily
- Weekly
- Total Daily

then accumulate over: Interval
- TInterval
- Monthly
- Daily
- Window

analyzing: Output Variable
- Max
- Min
- NDTG
- NOMN
- Mean
- NDIS

< > [0.00]
Ensemble Streamflow Prediction

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

Past <-> Future Time

5 days forecast precipitation
10 days forecast temperature

Historical time series of precipitation and temperature (from Calibration).
ESP Trace Ensemble of EAST - ALMONT
Latitude: 38.7  Longitude: 106.8
Forecast for the period 8/11/2006 24h - 8/16/2006 24h
This is a conditional simulation based on the current conditions as of 8/11/2006.

River Flow (CFS/D)

Trace Start Date
1976  1989
1977  1990
1978  1991
1979  1992
1980  1993
1981  1994
1982  1995
1983  1996
1984  1997
1985  1998
1986  1999
1987  2000
1988  2001

ACCUMULATION SETTINGS
Display Window
Forecast Start Date: 8-11-2006
Begin 0 1 2006
End 4 3 2006
Forecast End Date: 11-1-2006

first accum to:
- Daily Accum
  - None
  - Incl daily
  - Mean daily
  - Total daily

then accum over:
- Interval
  - TSInterval
  - Monthly
  - Daily
  - Window
  - Weekly
- Multiple
  - 1

analyzing:
Output Variable
- Max
- Sum
- NDMX
- Min
- NDTCI
- NDMN
- Mean
- NDIS

< 0.00

Apply  Frequency Settings
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

April – July Volume
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
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
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

**ACCUMULATION SETTINGS**

<table>
<thead>
<tr>
<th>Display Window</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forecast Start Date: 9-1-2006</td>
</tr>
<tr>
<td>Begin</td>
</tr>
<tr>
<td>End</td>
</tr>
<tr>
<td>Forecast End Date: 12-1-2006</td>
</tr>
</tbody>
</table>

**first accum to:**
- Daily Accum
  - None
  - Inst daily
  - Mean daily
  - Total daily

**then accum over:**
- Interval
  - TSInterval
  - Monthly
  - Daily
  - Weekly
  - Window

**analyzing:**
- Output Variable
  - Max
  - Sum
  - NDMX
  - Min
  - NDTO
  - NDMN
  - Mean
  - NDIS
  - < > 0.00

**Apply**  **Frequency Settings**
Can choose Probability Distribution

Can choose Exceedance Probability Levels
Display as Exceedance Probability plot

Chances of Exceeding River Levels on the EAST - ALMONT
Latitude: 38.7    Longitude: 106.8
Forecast for the period 9/15/2006 - 12/1/2006
This is a conditional simulation based on the current conditions as of 9/15/2006
```
# ENSEMBLE HEADER INFORMATION
# Segment: BMDCL F
# Trace File Name: BMDCLF.SIM24.SOME.24.CS
# Output Variable: Sum
# Data Type: RIVER DISCHARGE
# Units: AC-FT
# 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
KG: a=0.46 b=1.00 c=0.58 d=0.20 e=-0.07 min=105738.51 max=365172.80
EP1: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
EP2: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
EP3: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00
EP4: a=-999.00 b=-999.00 c=-999.00 d=-999.00 e=-999.00 min=-999.00 max=-999.00

Rainfall: a=0.86 b=1.23 c=1.14 d=0.08 e=-0.42 min=103938.28 max=293416.19

<table>
<thead>
<tr>
<th>Probability</th>
<th>Simulation</th>
<th>Historical</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.500</td>
<td>12738.422</td>
<td>134724.500</td>
<td>129883.516</td>
</tr>
<tr>
<td>0.750</td>
<td>153437.688</td>
<td>159569.953</td>
<td>167602.062</td>
</tr>
<tr>
<td>0.900</td>
<td>196325.000</td>
<td>204362.675</td>
<td>210600.641</td>
</tr>
<tr>
<td>0.950</td>
<td>240647.156</td>
<td>260056.166</td>
<td>245596.312</td>
</tr>
<tr>
<td>0.990</td>
<td>274206.079</td>
<td>317220.719</td>
<td>317923.369</td>
</tr>
</tbody>
</table>

# EMPIRICAL SAMPLE POINTS

<table>
<thead>
<tr>
<th>Year</th>
<th>Cond.</th>
<th>Hist.</th>
<th>Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>0.038</td>
<td>103938.281</td>
<td>0.963</td>
</tr>
<tr>
<td>1978</td>
<td>0.038</td>
<td>260804.816</td>
<td>0.570</td>
</tr>
<tr>
<td>1979</td>
<td>0.038</td>
<td>202663.000</td>
<td>0.440</td>
</tr>
<tr>
<td>1980</td>
<td>0.038</td>
<td>189062.516</td>
<td>0.693</td>
</tr>
<tr>
<td>1981</td>
<td>0.038</td>
<td>139886.078</td>
<td>0.693</td>
</tr>
<tr>
<td>1982</td>
<td>0.038</td>
<td>170389.344</td>
<td>0.667</td>
</tr>
<tr>
<td>1983</td>
<td>0.038</td>
<td>112977.336</td>
<td>0.526</td>
</tr>
<tr>
<td>1984</td>
<td>0.038</td>
<td>154665.922</td>
<td>0.776</td>
</tr>
<tr>
<td>1985</td>
<td>0.038</td>
<td>208192.538</td>
<td>0.747</td>
</tr>
<tr>
<td>1986</td>
<td>0.038</td>
<td>239416.180</td>
<td>0.637</td>
</tr>
<tr>
<td>1987</td>
<td>0.038</td>
<td>273184.122</td>
<td>0.622</td>
</tr>
<tr>
<td>1988</td>
<td>0.038</td>
<td>148963.219</td>
<td>0.615</td>
</tr>
<tr>
<td>1989</td>
<td>0.038</td>
<td>263176.141</td>
<td>0.480</td>
</tr>
<tr>
<td>1990</td>
<td>0.038</td>
<td>179433.931</td>
<td>0.630</td>
</tr>
<tr>
<td>1991</td>
<td>0.038</td>
<td>160696.953</td>
<td>0.741</td>
</tr>
<tr>
<td>1992</td>
<td>0.038</td>
<td>215623.340</td>
<td>0.533</td>
</tr>
<tr>
<td>1993</td>
<td>0.038</td>
<td>203670.375</td>
<td>0.607</td>
</tr>
<tr>
<td>1994</td>
<td>0.038</td>
<td>193036.344</td>
<td>0.681</td>
</tr>
<tr>
<td>1995</td>
<td>0.038</td>
<td>167261.781</td>
<td>0.704</td>
</tr>
<tr>
<td>1996</td>
<td>0.038</td>
<td>272151.469</td>
<td>0.148</td>
</tr>
<tr>
<td>1997</td>
<td>0.038</td>
<td>241533.547</td>
<td>0.222</td>
</tr>
<tr>
<td>1998</td>
<td>0.038</td>
<td>189311.562</td>
<td>0.556</td>
</tr>
<tr>
<td>1999</td>
<td>0.038</td>
<td>192971.628</td>
<td>0.519</td>
</tr>
<tr>
<td>2000</td>
<td>0.038</td>
<td>231815.094</td>
<td>0.259</td>
</tr>
<tr>
<td>2001</td>
<td>0.038</td>
<td>233238.344</td>
<td>0.296</td>
</tr>
<tr>
<td>2002</td>
<td>0.038</td>
<td>141599.656</td>
<td>0.652</td>
</tr>
</tbody>
</table>
```
1 Week Chances of Exceeding River Levels on the EAST - ALMONT

Latitude: 38.7   Longitude: 106.8
Forecast for the period 9/15/2006 - 12/1/2006
This is a conditional simulation based on the current conditions as of 9/15/2006

Exceedance Probability
- Green: 10 - 25%
- Yellow: 25 - 50%
- Red: 50 - 75%
- Blue: 75 - 90%
- Gray: >= 90%