

ESP/AHPS

Probabilistic Forecasting

Dave Brandon - HIC

Colorado Basin River Forecast Center

Salt Lake City, Utah



ESP/AHPS

Presentation Outline

1. Introduction: Probability & Ensembles
2. Overview: Ensemble Streamflow Prediction (ESP)
3. Common Suite of Products
4. Enhanced RFC PRODUCTS
5. Strengths and limitations

What is an ensemble Forecast ?

An ensemble forecast is a collection of two or more forecasts that verify at the same time.

Old Hydrograph Ensemble Method



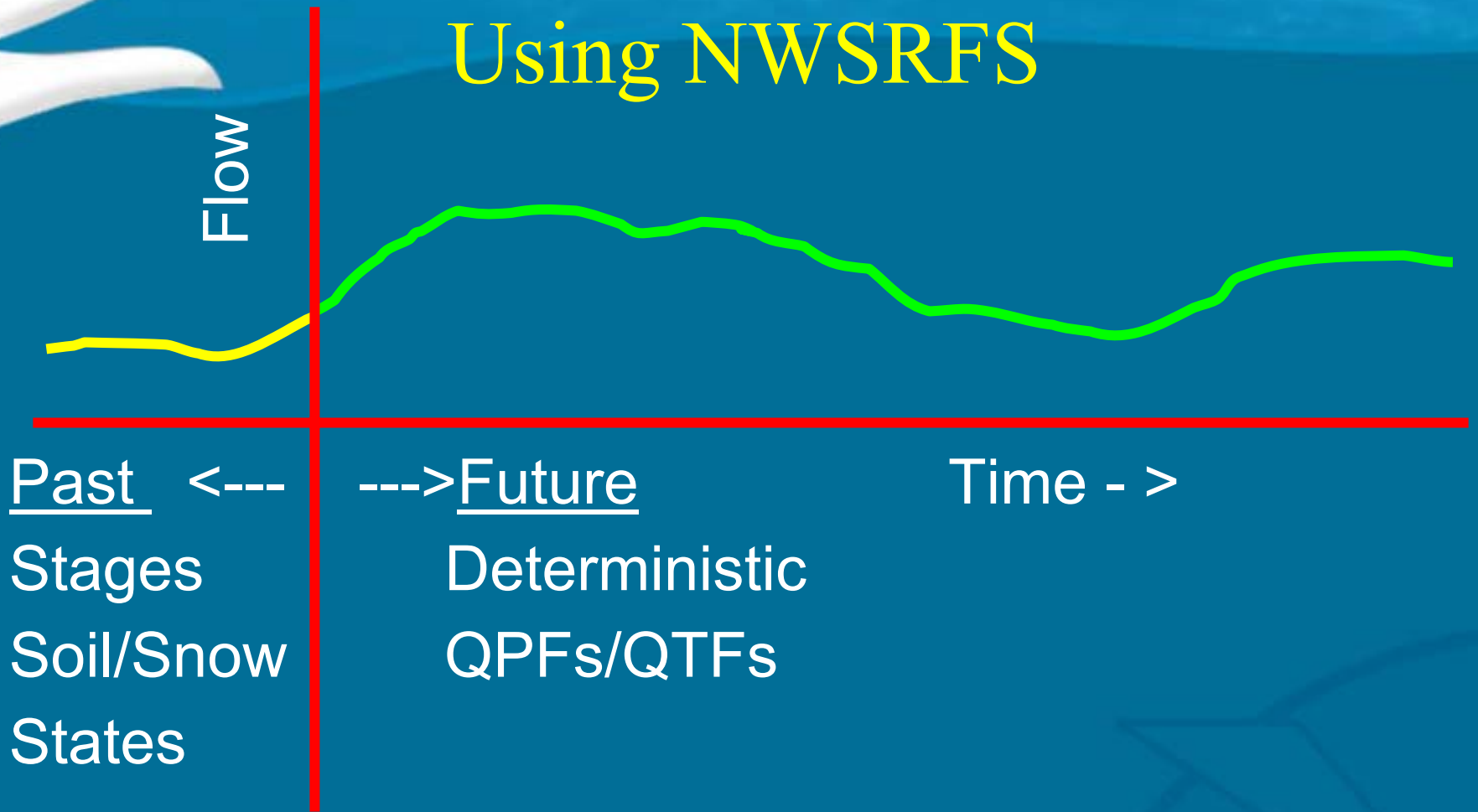
Why do you even care about ensembles ???

It is the preferred way to create Probabilistic river forecasts....

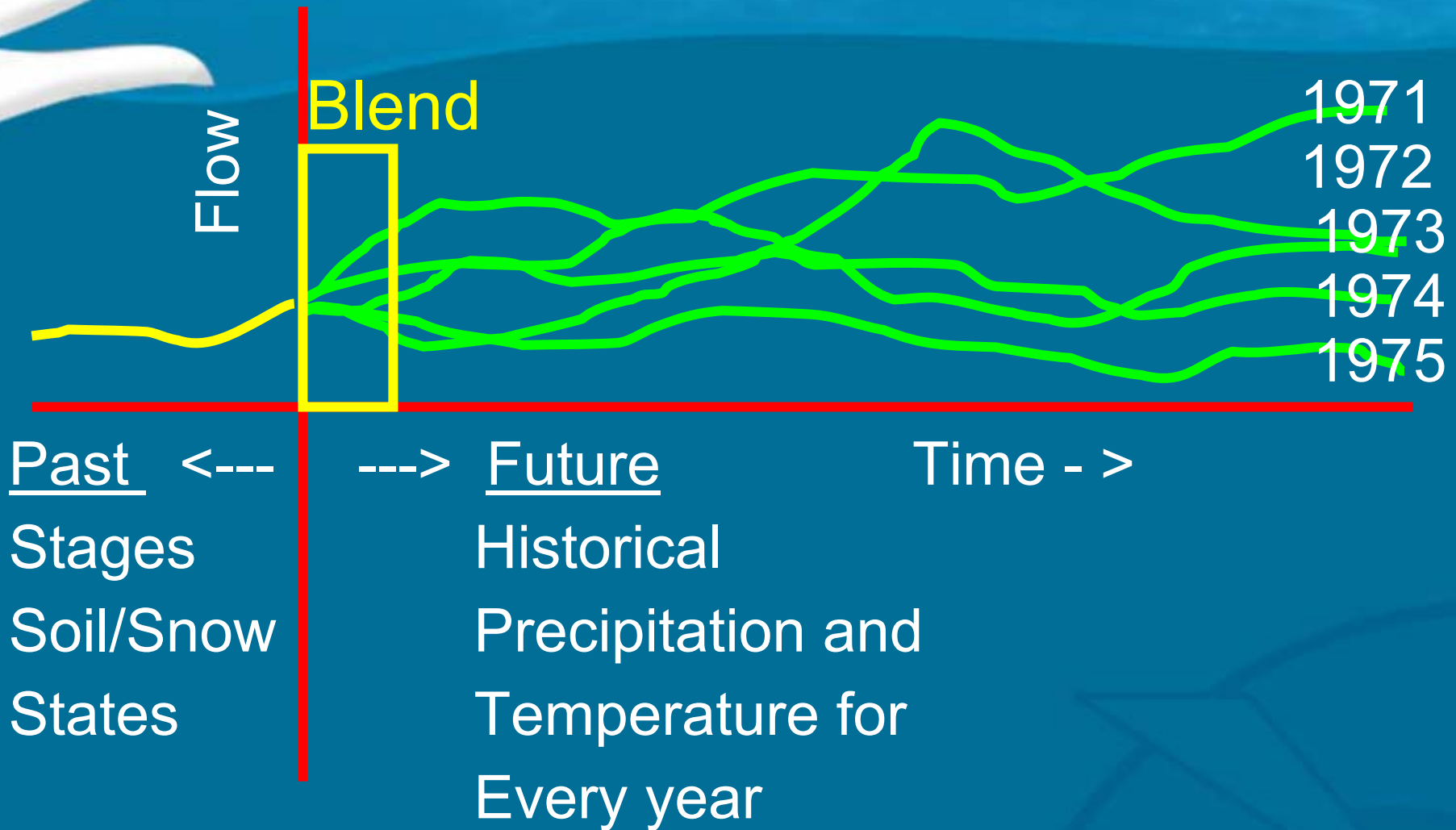
And...

A significant part of AHPS is.. Probabilistic Forecasting.

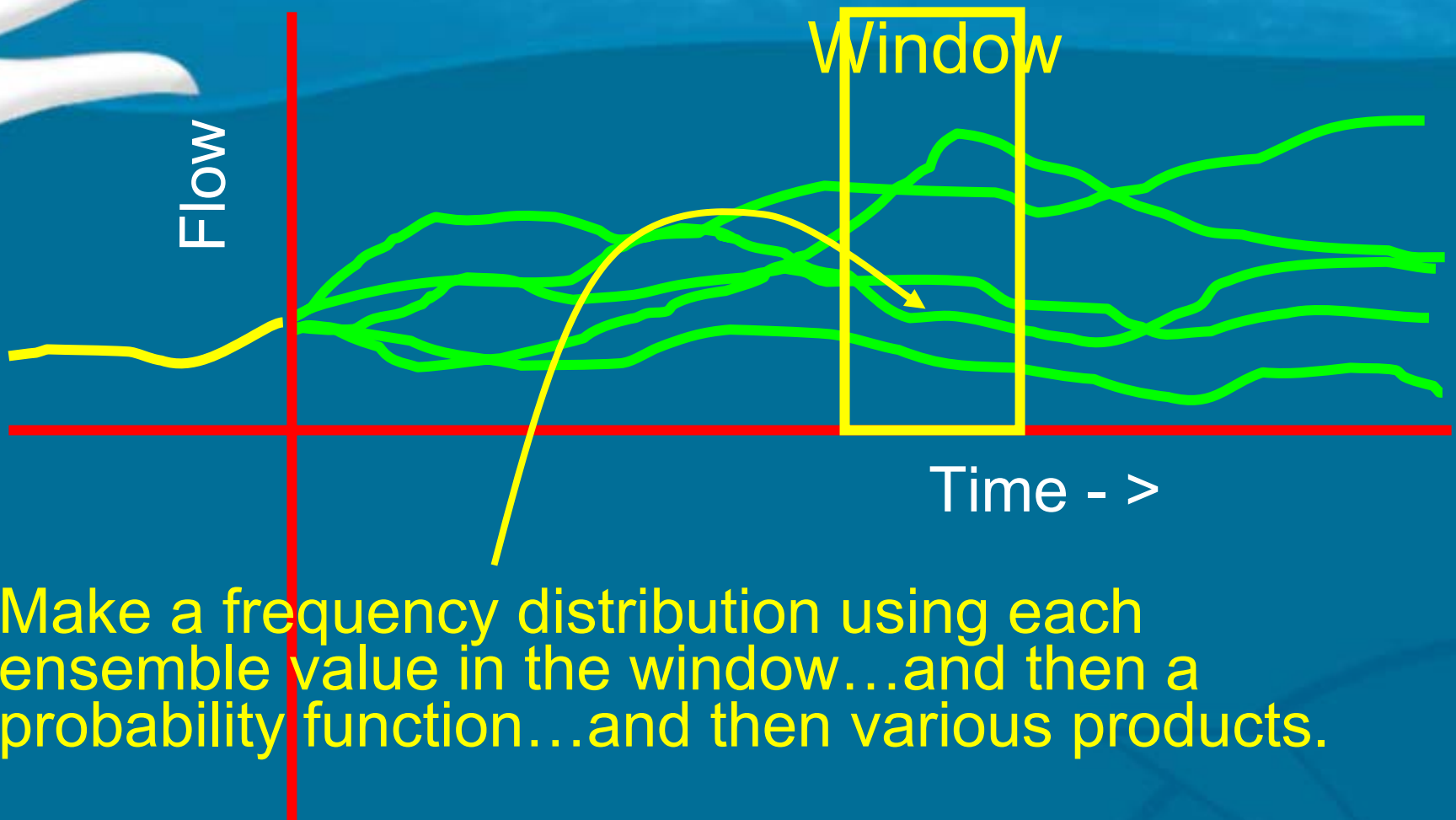
Making a Deterministic Forecast Using NWSRFS



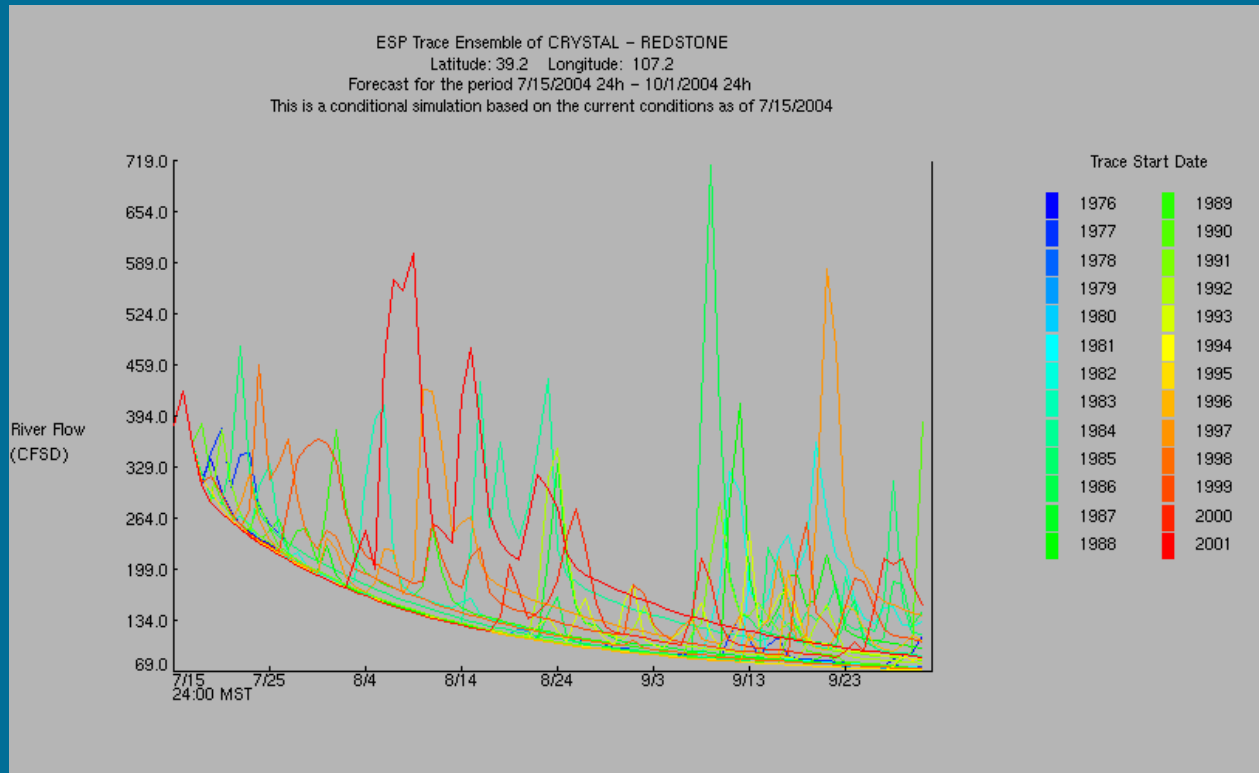
Making an Ensemble Forecast Using NWSRFS



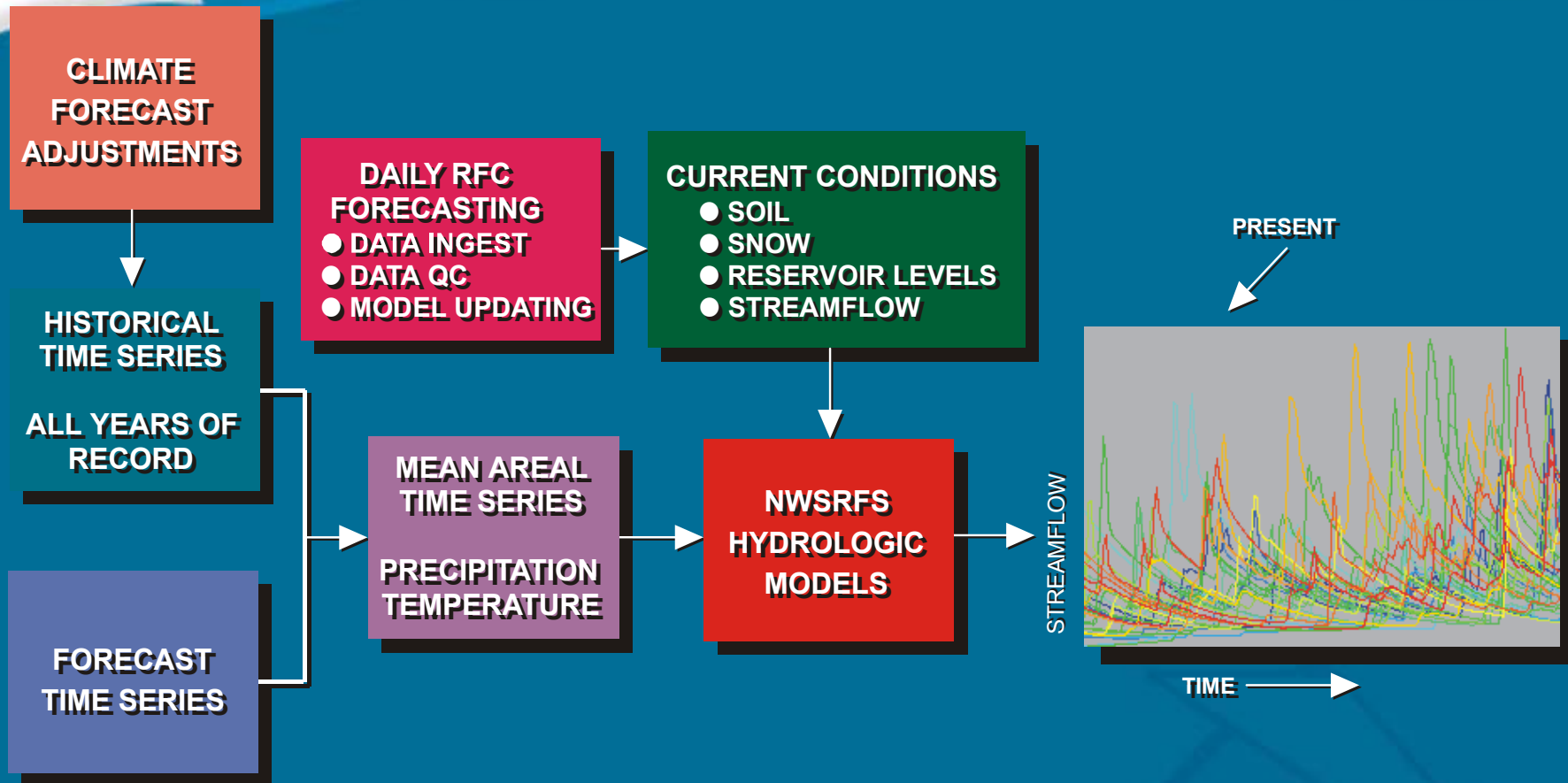
Making an Ensemble Forecast Using NWSRFS



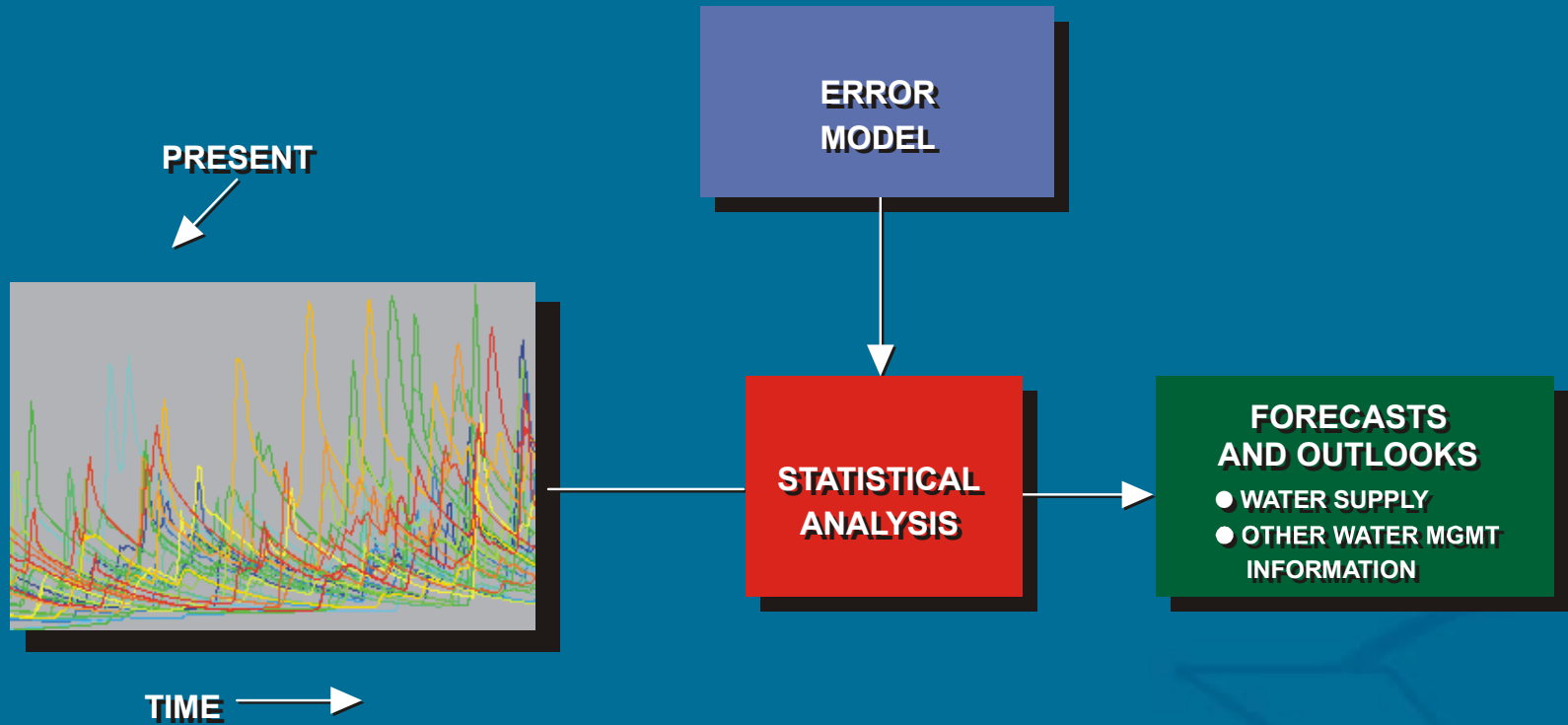
ESP Trace Ensemble for Crystal River at Redstone Using 1976-2001 Historical Data



ESP Trace Generation

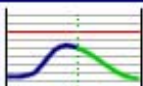
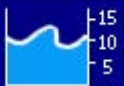







ESP Statistical Analysis



Common Suite of Probabilistic Products

The screenshot shows the website header for the National Weather Service Colorado Basin River Forecast Center. The header includes the NOAA logo, the text "NATIONAL WEATHER SERVICE" and "Colorado Basin River Forecast Center", and navigation links for "Home", "News", and "Organization". A search bar with a "Go" button is also present. Below the header is a main content area with a grid of product tiles. On the left, there is a sidebar with links for "River Forecasts & Data", "Graphic", "List", "RCYC2 Data", "Hydrograph", and "RCYC2 Gage Info".

 Hydrograph River Level Forecast Info	 Stage Weekly Chance of Exceedance	 Flow Weekly Chance of Exceedance	 Volume Weekly Chance of Exceedance	 Stage Chance of Exceedance During Entire Period	 Flow Chance of Exceedance During Entire Period	 Build a Product
---	--	---	--	--	---	---



Common Suite: Deterministic Hydrograph

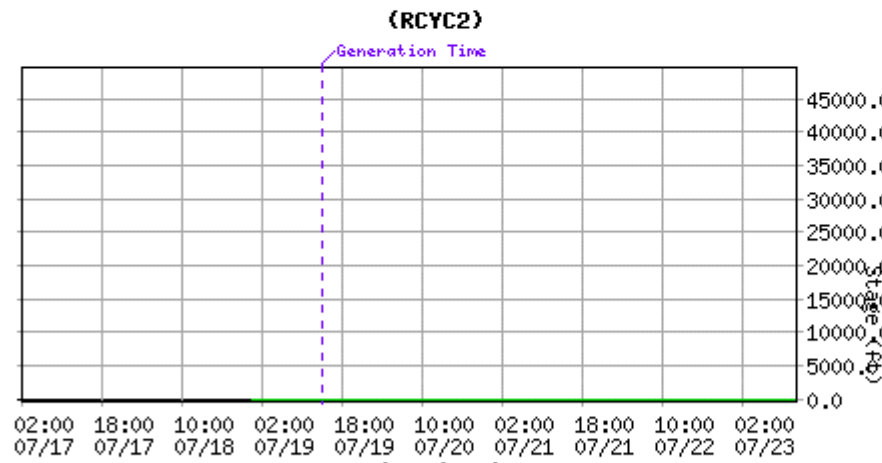
Crystal River near Redstone
 Observations courtesy of the US Geological Survey.
Flood Stage: 5 Feet

Latest Stage: 1.9 Feet at 00:00 GMT 07/19
[\[Graph Description\]](#) [\[Feedback\]](#) [\[Text Products\]](#) [\[Precip.\]](#)
[\[Impacts\]](#) [\[Map\]](#) [\[Historical Crests\]](#) [\[Low Water Events\]](#)

[Click Here for
 Crystal River
 at a Glance](#)

 Hydrograph	 Stage	 Flow	 Volume	 Stage	 Flow
River Level Forecast Info	Weekly Chance of Exceedance			Chance of Exceedance During Entire Period	

- Animas River -
- Cimarron River -
- Colorado River -
- Crystal River -
- Dallas Creek -
- Dolores River -
- Duchesne River -
- Eagle River -
- East River -
- Elk River -
- Elkhead Creek -
- Florida River -
- Frying Pan River -
- Green River -
- Gore Creek -
- Gunnison River -
- La Plata River -
- Little Snake River -
- Los Pinos River -
- Mancos River -
- Muddy Creek -



Observed — Forecast — Bankfull — Flood —

Latest: 0.0 ft [10:15 07/19]
 Max: NONE Max Fcst: 1.9ft
 Min: NONE Min Fcst: 1.7ft

Subtract 6 hrs for MDT, 7 hrs for MST

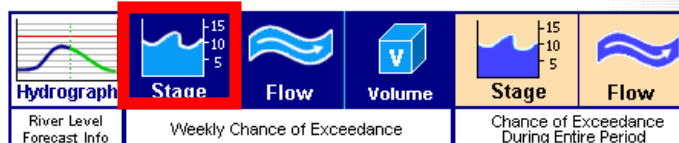
**Tabular
 Data**

Common Suite: Weekly Exceedance-Stage

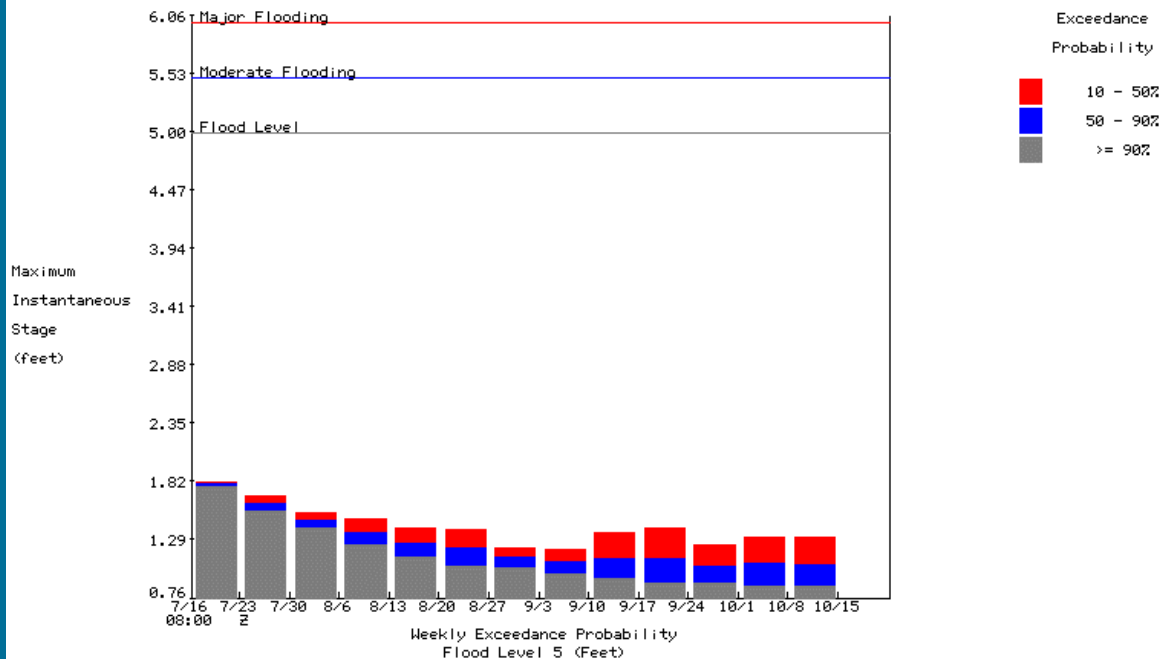
Crystal River near Redstone
 Observations courtesy of the US Geological Survey.
Flood Stage: 5 Feet

Latest Stage: 2.1 Feet at 00:00 GMT 07/16

[Graph Description] [Feedback] [Text Products] [Precip.]
 [Impacts] [Map] [Historical Crests] [Low Water Events]



1 Week Chances of Exceeding River Levels on the CRYSTAL at REDSTONE, NR, AVALAN
 Latitude: 39.2 Longitude: 107.2
 Forecast for the period 7/16/2004 - 10/15/2004
 This is a conditional simulation based on the current conditions as of 7/16/2004



This probabilistic forecast is issued by the Colorado River Forecast Center.

Common Suite: Weekly Exceedance-Flow

Crystal River near Redstone

Observations courtesy of the US Geological Survey.

Flood Stage: 5 Feet

Latest Stage: 2.1 Feet at 00:00 GMT 07/16

[\[Graph Description\]](#) [\[Feedback\]](#) [\[Text Products\]](#) [\[Precip.\]](#)

[\[Impacts\]](#) [\[Map\]](#) [\[Historical Crests\]](#) [\[Low Water Events\]](#)

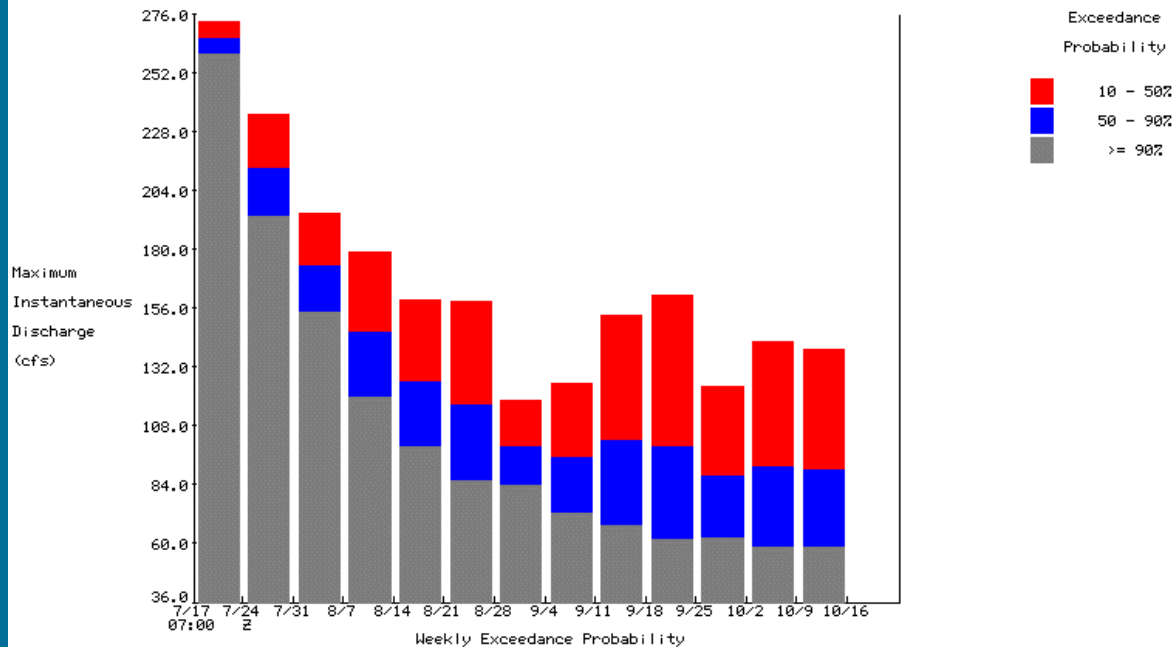


1 Week Chances of Exceeding River Levels on the CRYSTAL - REDSTONE

Latitude: 39.2 Longitude: 107.2

Forecast for the period 7/17/2004 - 10/16/2004

This is a conditional simulation based on the current conditions as of 7/17/2004



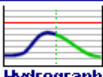
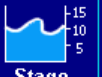


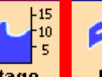

This probabilistic forecast is issued by the [Colorado River Forecast Center](#).

Common Suite: 90-Day Exceedance-Stage

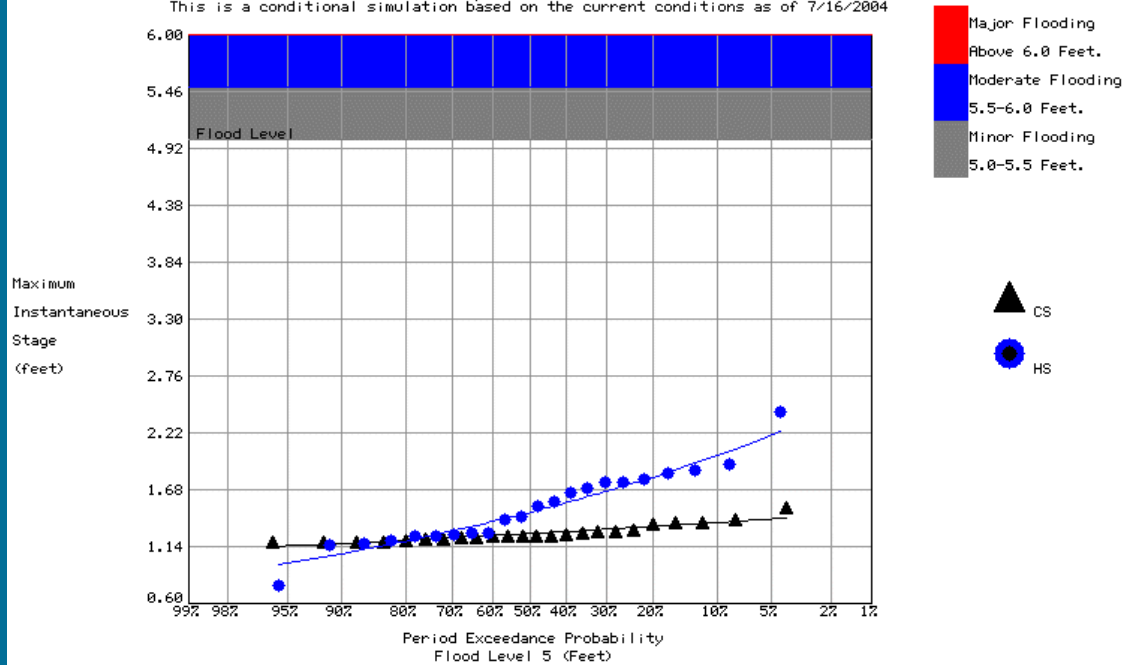
Crystal River near Redstone
 Observations courtesy of the US Geological Survey.
Flood Stage: 5 Feet

Latest Stage: 2.1 Feet at 00:00 GMT 07/16

[Graph Description] [Feedback] [Text Products] [Precip.]
 [Impacts] [Map] [Historical Crests] [Low Water Events]

 Hydrograph	 Stage	 Flow	 Volume	 Stage	 Flow
River Level Forecast Info	Weekly Chance of Exceedance			Chance of Exceedance During Entire Period	

Chances of Exceeding River Levels on the CRYSTAL at REDSTONE, NR, AVALAN
 Latitude: 39.2 Longitude: 107.2
 Forecast for the period 7/16/2004 - 10/15/2004
 This is a conditional simulation based on the current conditions as of 7/16/2004



This probabilistic forecast is issued by the [Colorado River Forecast Center](#).

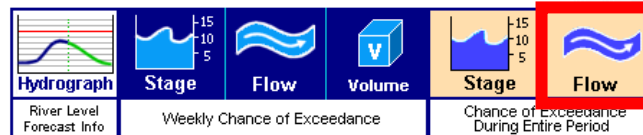
Common Suite: 90-Day Exceedance-Flow

Crystal River near Redstone
Observations courtesy of the US Geological Survey.

Flood Stage: 5 Feet

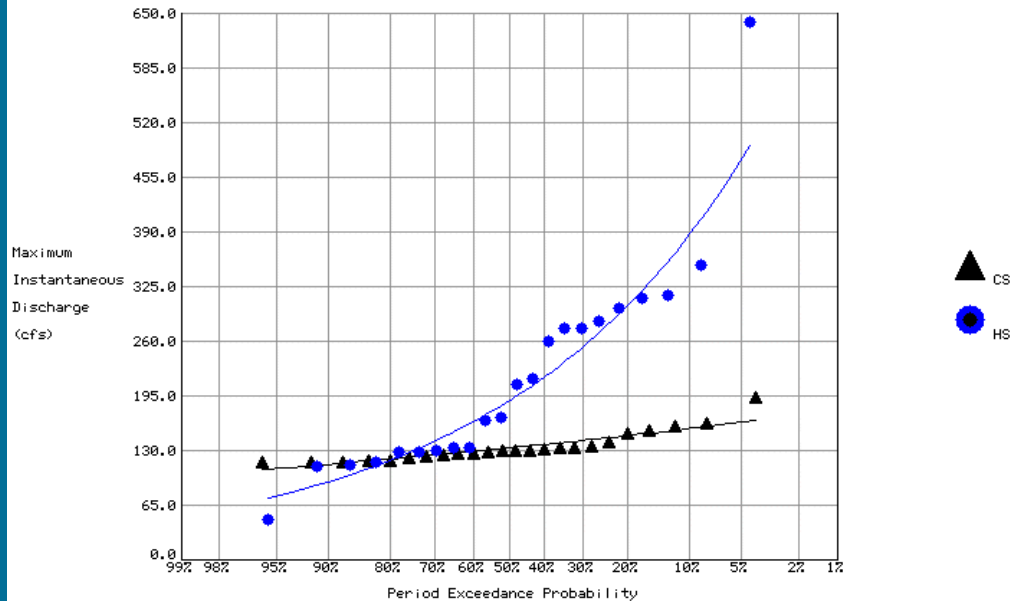
Latest Stage: 2.1 Feet at 00:00 GMT 07/16

[Graph Description] [Feedback] [Text Products] [Precip.]
[Impacts] [Map] [Historical Crests] [Low Water Events]



Chances of Exceeding River Levels on the CRYSTAL - REDSTONE
Latitude: 39.2 Longitude: 107.2
Forecast for the period 7/17/2004 - 10/16/2004

This is a conditional simulation based on the current conditions as of 7/17/2004



This probabilistic forecast is issued by the Colorado River Forecast Center.

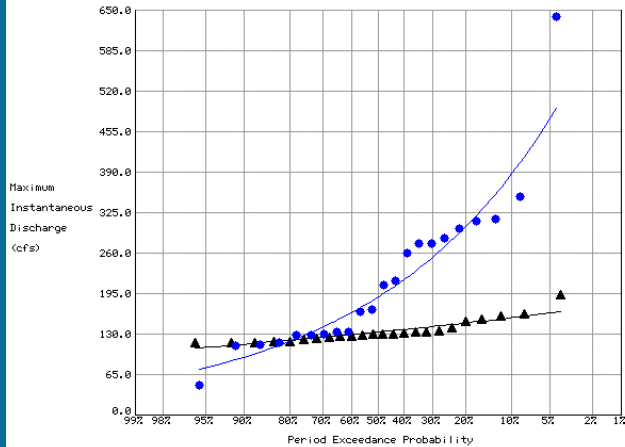
Crystal River near Redstone
 Observations courtesy of the US Geological Survey.
 Flood Stage: 5 Feet

Latest Stage: 2.1 Feet at 00:00 GMT 07/16
[\[Graph Description\]](#) [\[Feedback\]](#) [\[Text Products\]](#) [\[Precip.\]](#)
[\[Impacts\]](#) [\[Map\]](#) [\[Historical Crests\]](#) [\[Low Water Events\]](#)



Chances of Exceeding River Levels on the CRYSTAL - REDSTONE
 Latitude: 39.2 Longitude: 107.2
 Forecast for the period 7/17/2004 - 10/16/2004

This is a conditional simulation based on the current conditions as of 7/17/2004

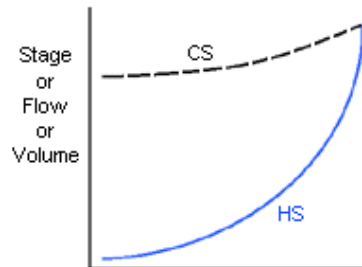


This probabilistic forecast is issued by the Colorado River Forecast Center.

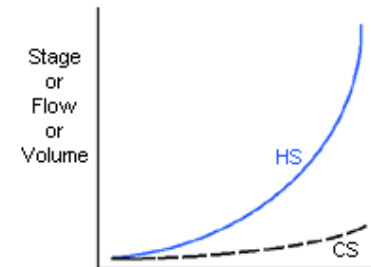
Explanation : 90 Day Exceedance



Here are some possible scenarios to help you understand this graphic:



More wet than "normal" conditions over the forecast period.
 The chances are greater for wet conditions, as indicated by the **Conditional Simulation**, over the entire range of possible outcomes.



More dry than "normal" conditions over the forecast period.
 The chances are greater for dry conditions, as indicated by the **Conditional Simulation**, over the entire range of possible outcomes.

When the two simulations are very close across the entire range, the chances of the river going over a certain level is similar to the total range of past levels.

Enhanced Products From the CBRFC

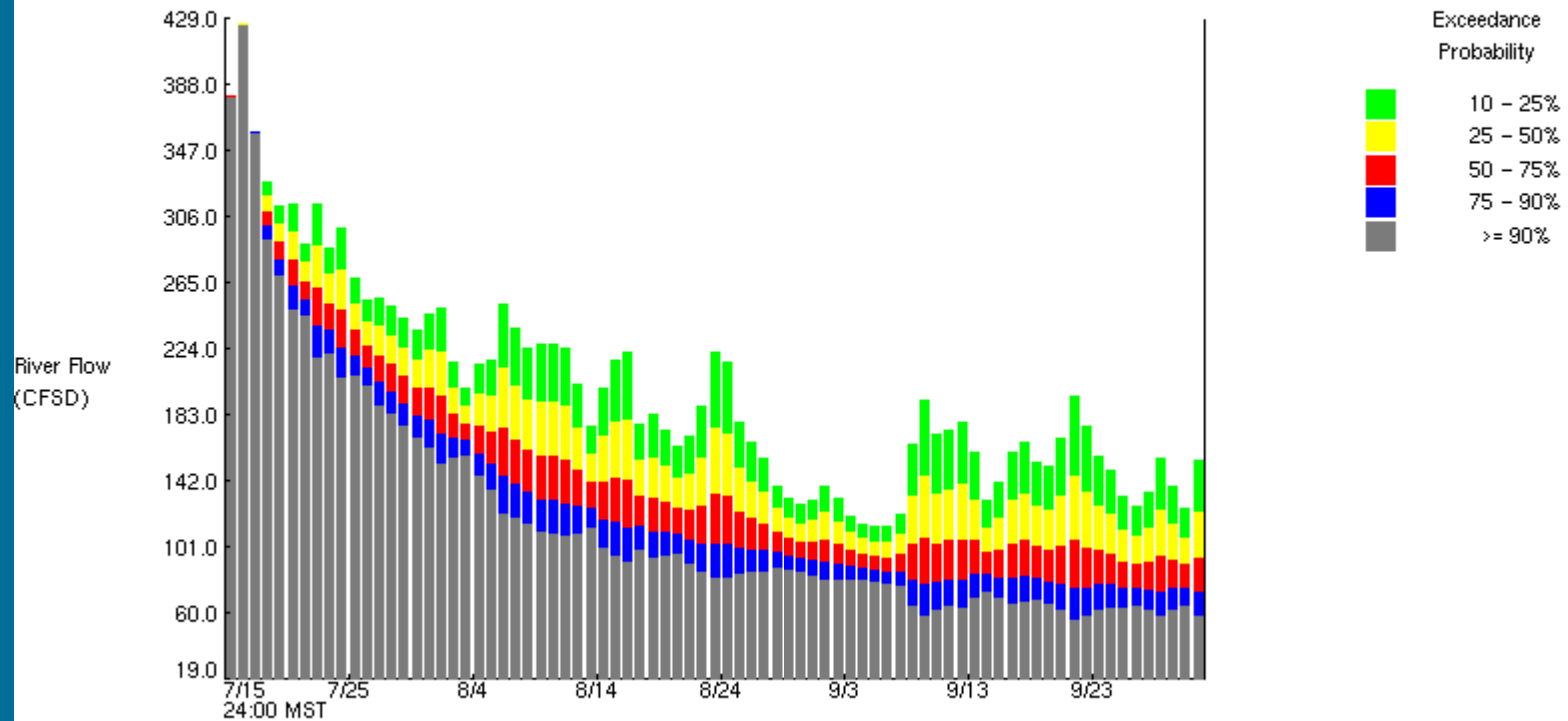
Products from ESP-ADP

Products on the Web

Build your Own

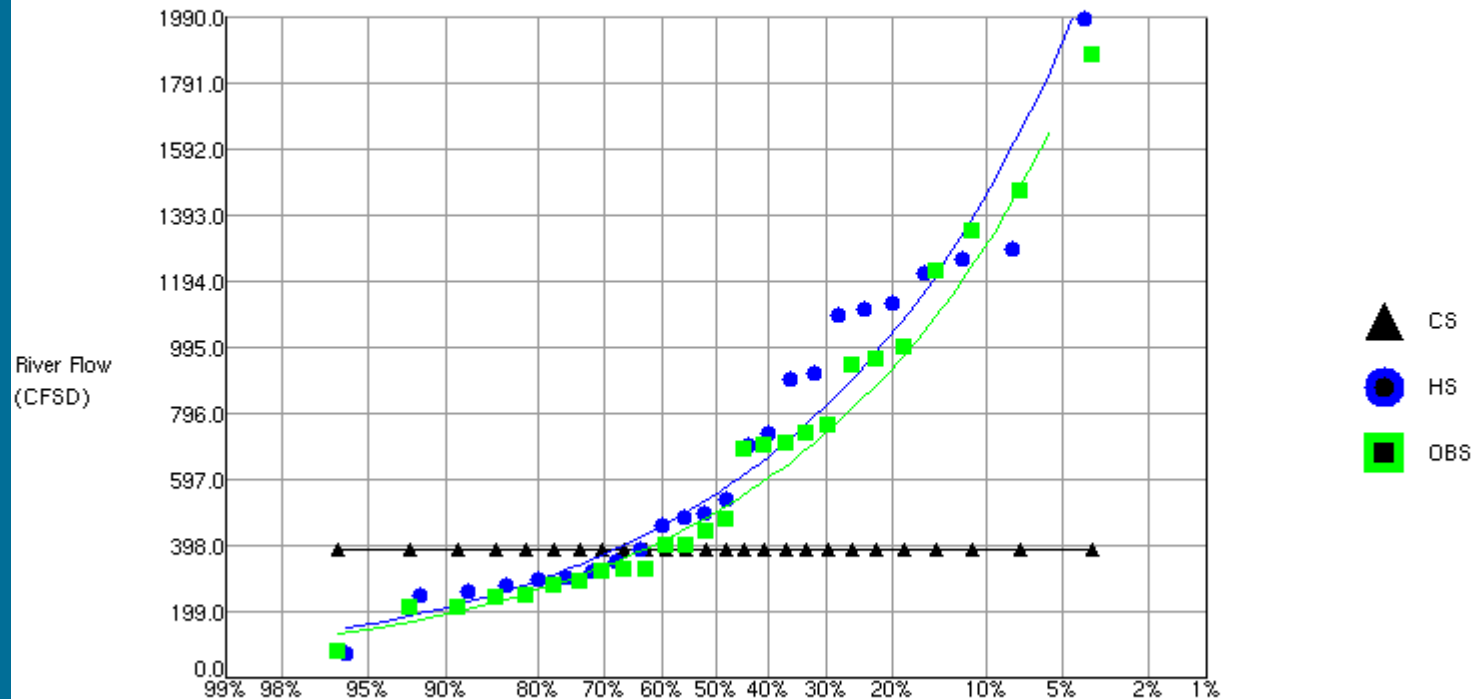
Enhanced: Daily Exceedance - Flow

24 Hour Chances of Exceeding River Levels on the CRYSTAL - REDSTONE
Latitude: 39.2 Longitude: 107.2
Forecast for the period 7/15/2004 24h - 10/1/2004 24h
This is a conditional simulation based on the current conditions as of 7/15/2004



Enhanced: Daily Exceedance – Flow With Historical, Conditional, Observed

Chances of Exceeding River Levels on the CRYSTAL – REDSTONE
Latitude: 39.2 Longitude: 107.2
Forecast for the period 7/15/2004 24h – 7/16/2004 24h
This is a conditional simulation based on the current conditions as of 7/15/2004



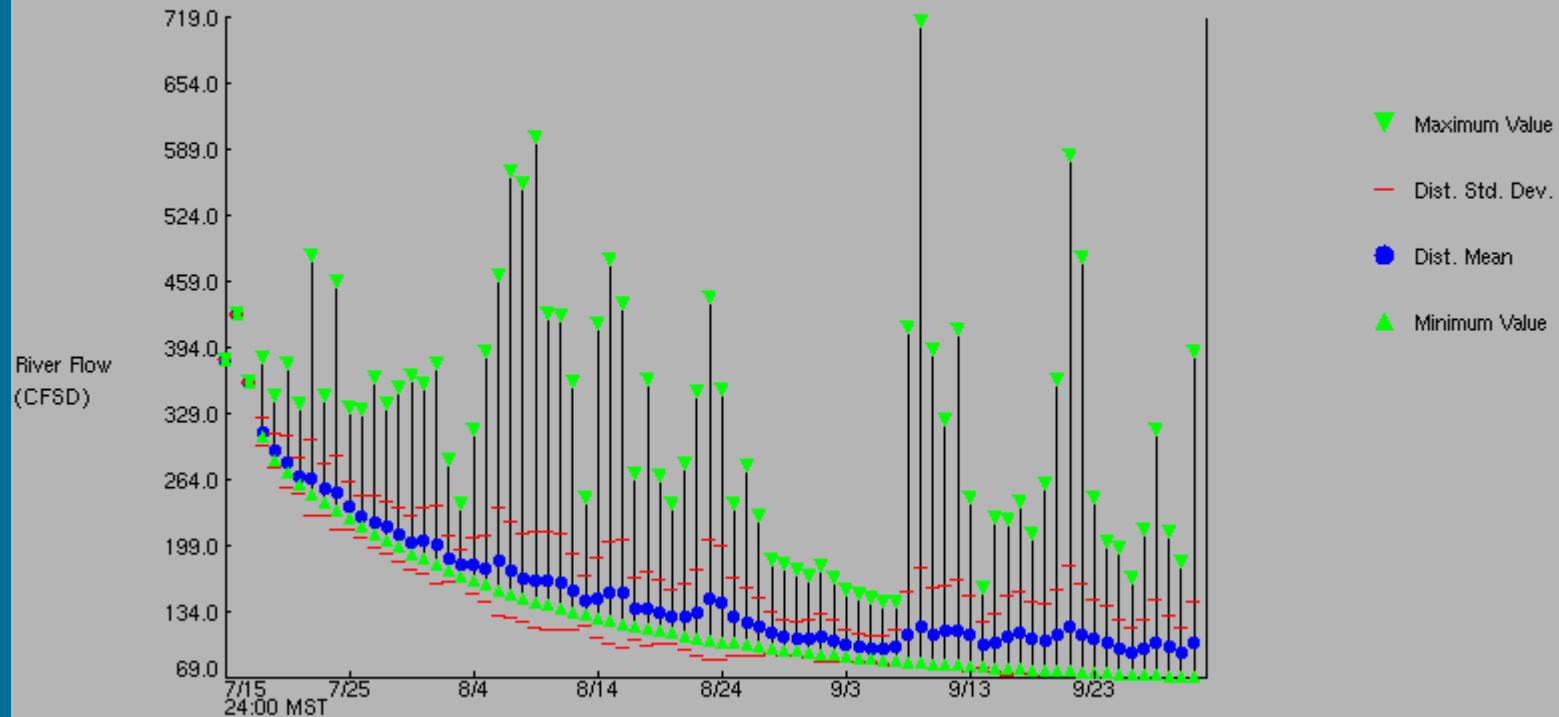
Enhanced: Expected Value Plot

ESP Expected Value of CRYSTAL - REDSTONE

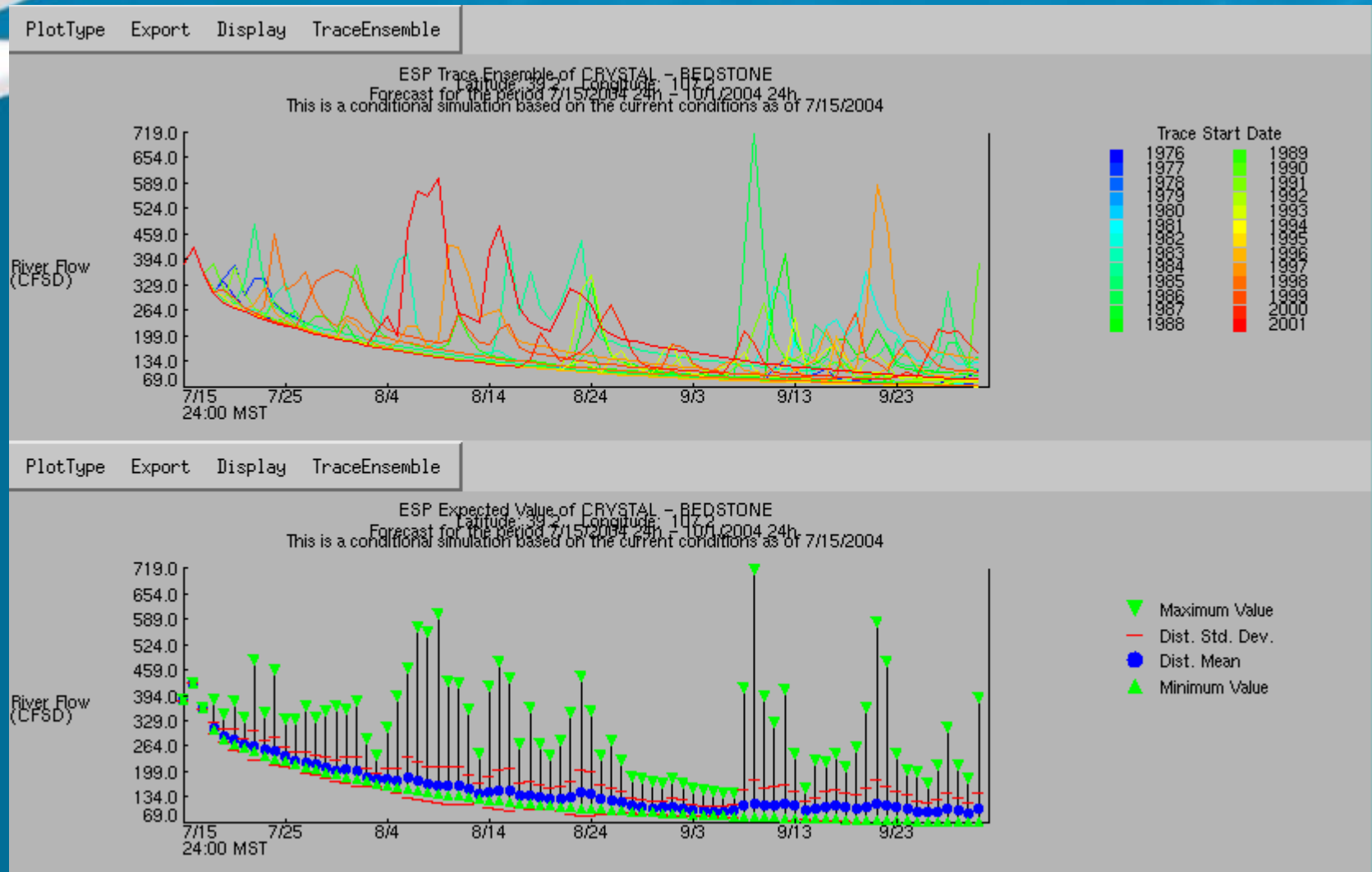
Latitude: 39.2 Longitude: 107.2

Forecast for the period 7/15/2004 24h - 10/1/2004 24h

This is a conditional simulation based on the current conditions as of 7/15/2004



Enhanced: Dual Plot For Comparisons



Enhanced: Web Product

www.nws.noaa.gov



NATIONAL WEATHER SERVICE

Colorado Basin River Forecast Center



Home

News

Organization

Search

Go

River Forecasts & Data

Graphic
List

APNC2 Data/Forecasts

Hydrograph
Probabalistic
Water Supply

APNC2 Model Data

Precipitation
Temperature
Freezing Level
Snow Information
Soil Moisture
Combination Plot

APNC2 Gage Info

Conditions Map Location
Basin/Location Maps
Aerial Photos/Topo Maps
Photos
Gage Information
Records
Rating Table

APNC2 Verification

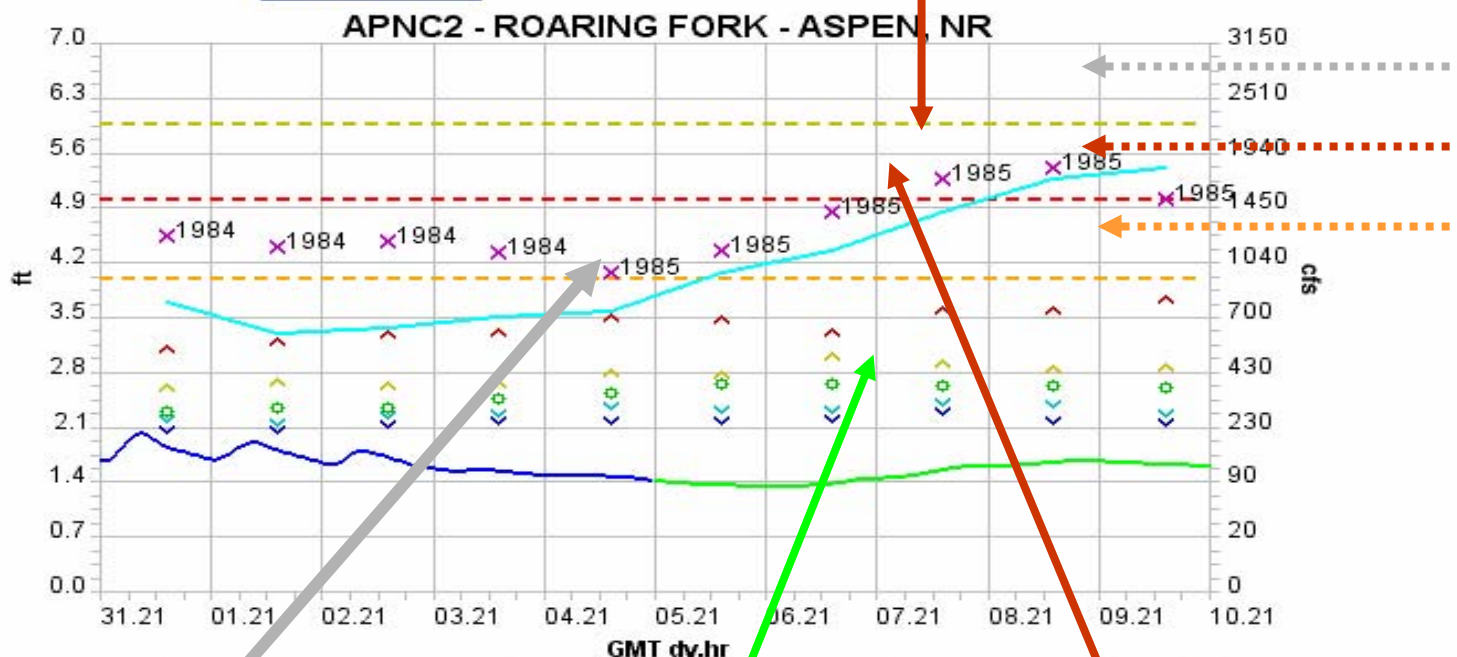
Short Range
Long Range (ESP)
Water Supply
Model Simulation

Back to Main Menu

Hydrograph	Stage	Flow	Volume	Stage	Flow	Build a Product
River Level Forecast Info	Weekly Chance of Exceedance			Chance of Exceedance During Entire Period		Build a Product

APNC2 Observed/Simulated Hydrograph

The current time is: 06/05 21:47 GMT.



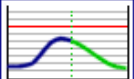
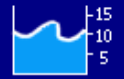





Colorado Basin River Forecast Center, NWS/NOAA

[Hide Flood Stage](#) | [Show Simulated](#) | [Linear Flow](#) | [Hide Historical Peak](#) | [Hide Daily Maxima](#) | [Hide Statistics](#) |
[Show ESP](#) | [Remove Adjustment](#) | [Requery from elk](#) | [Requery from awips](#) | [Plot Cache](#)

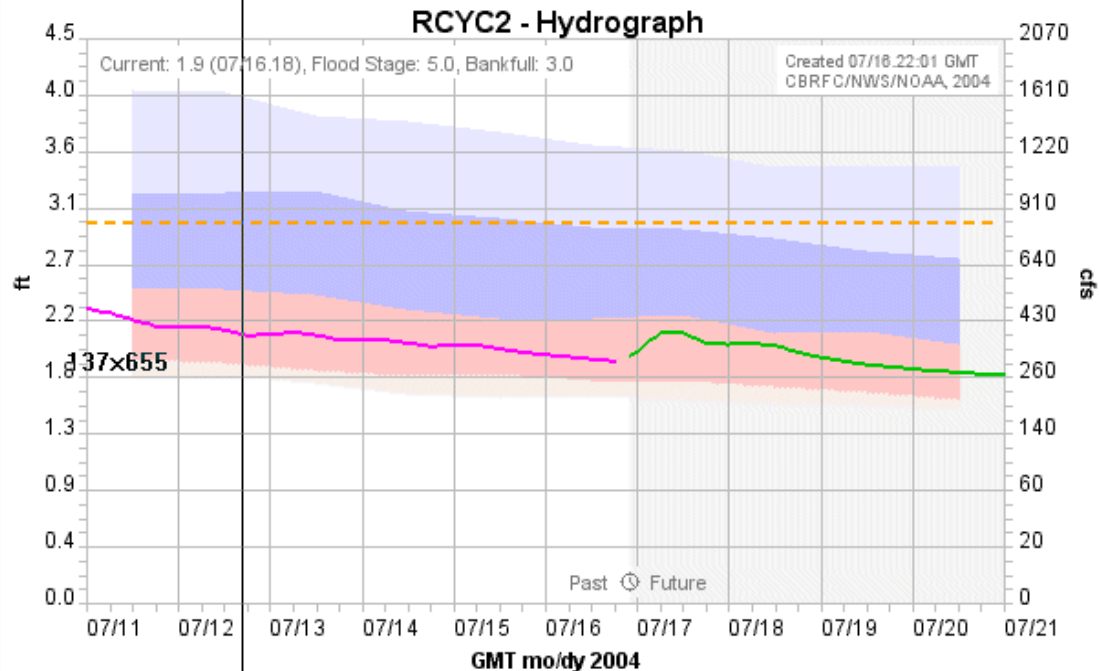
Add Year: [84](#) [02](#) [01](#) [00](#) [99](#) [98](#) [97](#) [96](#) [95](#) [94](#) [93](#) [92](#) [91](#) [90](#) [89](#) [88](#) [87](#) [86](#) [84](#) [83](#) [82](#) [81](#) [80](#) [79](#) [78](#) [77](#) [76](#) [75](#) [74](#) [73](#) [72](#) [71](#) [70](#)

Delete Year: [85](#)

Enhanced: Web Product

 Hydrograph	 Stage	 Flow	 Volume	 Stage	 Flow	 Build a Product
River Level Forecast Info	Weekly Chance of Exceedance			Chance of Exceedance During Entire Period		

CRYSTAL - REDSTONE, NR, AVALANCHE CK, ABV (RCYC2)



Observed (USGS) — Simulated — Forecast (07/16.22:00) — Bankfull 3.0 —
Historical Exceedance Probability (USGS): 90-75% 75-50% 50-25% 25-10%

Hydrograph Options

<input type="checkbox"/> Flood Stage	Years	Date
<input type="checkbox"/> Simulated	1956	07/16/04
<input type="checkbox"/> Raw Data	1957	Past Days
<input type="checkbox"/> Linear Flow	1958	5
	1959	

Graphs

<input type="checkbox"/> Precipitation	<input type="checkbox"/> Temperature
<input type="checkbox"/> Temperature	<input type="checkbox"/> Freezing Level
<input type="checkbox"/> Freezing Level	<input type="checkbox"/> Snow
<input type="checkbox"/> Snow	

Tabular Data

<input type="checkbox"/> Precipitation	<input type="checkbox"/> Temperature
<input type="checkbox"/> Temperature	<input type="checkbox"/> Freezing Level
<input type="checkbox"/> Freezing Level	<input type="checkbox"/> Snow
<input type="checkbox"/> Snow	

Information

<input type="checkbox"/> Gage Info
<input type="checkbox"/> Basin/Location Maps
<input type="checkbox"/> Aerial/Topo 16 mpp
<input type="checkbox"/> Photos

Enhanced: Build Your Own



NATIONAL WEATHER SERVICE

Colorado Basin River Forecast Center

[Home](#)

[News](#)

[Organization](#)

Search

Advanced Hydrologic Prediction Service

[Graphic](#)

[Description](#)

[Operational Prototype](#)

[Concepts](#)

[Back to Main Menu](#)

AHPS / ESP Trace Analysis

ESP Trace File

Blue Mesa 24hr Conditional.
Fontenelle 24hr Conditional.
Powell 24hr Conditional.
Flaming Gorge 24hr Conditional.
Navajo 24hr Conditional.
Green - Warren Bridge 24hr Cond.

Accumulation Type

- Mean
 Max
 Min
 Sum

Interval

- Day
 Week
 Month
 Entire Period

Analysis Window

Plot Options:

- Traces Probability Expected Value Exceedance

Table Options:

- Forecastinfo Quantiles Floodquantiles

Strengths For ESP Forecasting

Uses the current conditions of model to project possible scenarios.

1. Soil moisture conditions

Accounts for Drought/Wet Conditions

2. Snow conditions

3. River flow

4. Reservoir elevations

Strengths For ESP Forecasting

Provides Probabilistic Information For
Various Applications

1. Spring Flood Outlooks
2. Water Supply Forecasts
3. Drought Analysis
4. Hydropower Planning
5. Fisheries Management
6. Recreation
7. Navigation
8. Reservoir Inflow Forecasts

Current Limitations For ESP Forecasting

- River Regulation.
Model Reservoir/Irrigation/Diversion operating criteria – very difficult task.
- Relies on historical MAP/MAT and simulated flows...requires good calibrations.
- How do we provide this information in a useful manner.