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# CBRFC Operations Update Water Year 2022



Colorado River Forecasting Service (CRFS) Meeting  
November 18, 2021

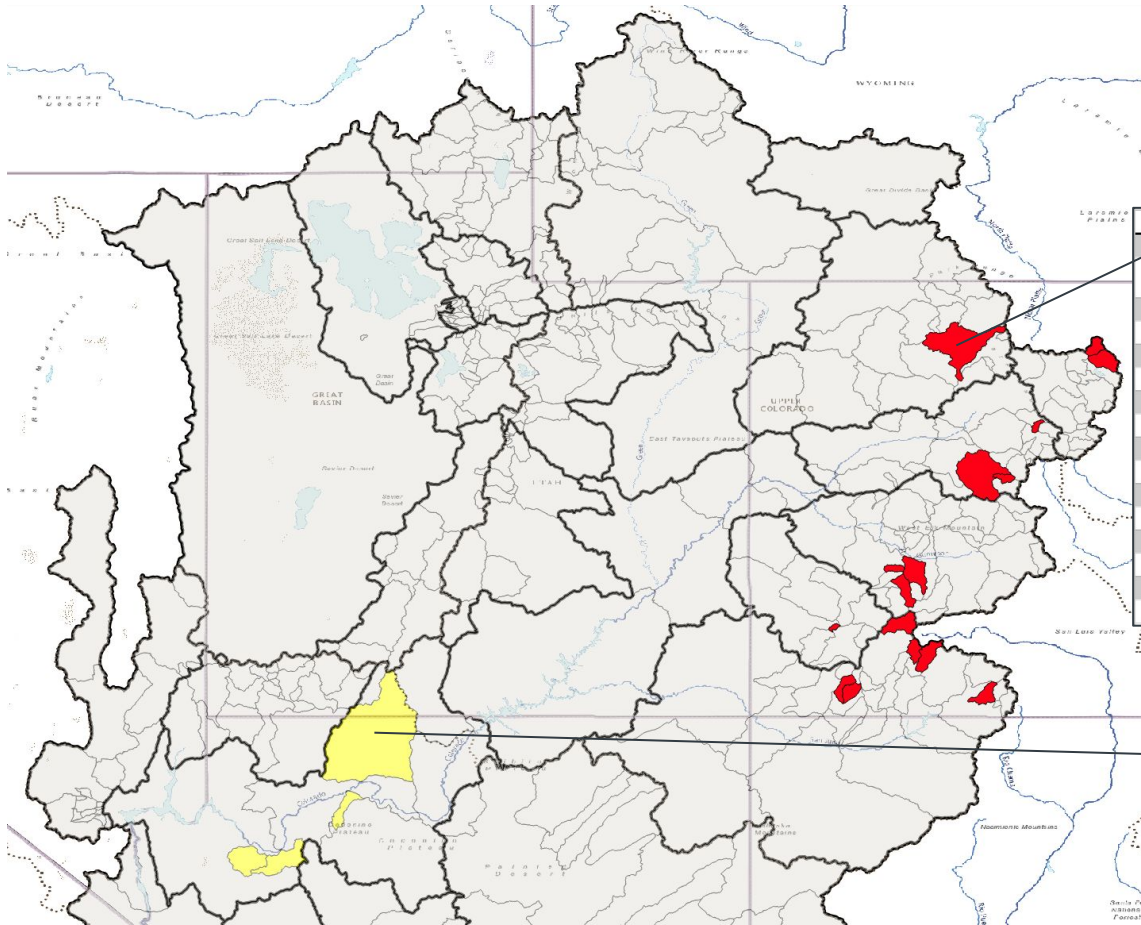
# CBRFC WY22 Operations Update

- Model calibration update
- 1991-2020 normals update
- Multi-year model soil moisture graphics
- 10-day streamflow forecast hydrograph updates
- Water Year 2022
  - Forecast point changes
  - Basin focal points

# CBRFC Model Updates

- Model calibration period: 1981-2020
- Official Forecast ESP period: 1991-2020
  - Still generating full period 1981-2020 ESP traces
- Basin elevation zone standardization across western Colorado
  - 11,000'+, 9,500', 8,000', 6,500', etc.
  - Allows for more consistent twice monthly model snow updates
- New model segments
- Consumptive Use Model Improvements
- Improved snow model calibration procedures
- New SNOTELs

# CBRFC Recent Hydrologic Model Additions



ID	DESCRIPTION	BASIN
YAHC2	YAMPA - ELKHEAD CK- ABV- HAYDEN- NR	White/Yampa
BAKC2	COLORADO - BAKER GULCH- BLO- GRAND LAKE- NR	UC Mainstem
SMRC2	COLORADO - SHADOW MTN RES- GRAND LK- NR	UC Mainstem
GORC2	GORE CK - MOUTH- MINTUR- NR	UC Mainstem
HUTC2	HUNTER CK - ASPEN	UC Mainstem
EMMC2	ROARING FK - EMMA- NR	UC Mainstem
CMNC2	CIMARRON - SQUAW CK- BLO- CIMARRON- NR	Gunnison
COWC2	COW CK - RIDGWAY RESERVOIR- NR	Gunnison
UNBC2	UNCOMPAGRE - UNCOMPAGRE ROAD BRIDGE	Gunnison
GRHC2	GROUNDHOG RESERVOIR	Gunnison
RIOC2	RIO BLANCO - MOUTH- TRUJILLO- NR	San Juan
VNBC2	VALLECITO CK - BAYFIELD- NR	San Juan
LPAC2	LOS PINOS - VALLECITO RESERVOIR- ABV	San Juan
ANBC2	ANIMAS - SILVERTON- BLO	San Juan
CYKC2	CHERRY CREEK - MOUTH- RED MESA- NR	San Juan
LPCC2	LA PLATA - CHERRY CK- BLO- RED MESA- NR	San Juan

ID	DESCRIPTION
KCSA3	KANAB CK - MOUTH, AVG, SUPAI, NR
HNSA3	HAVASU CK - MOUTH- ABV- SUPAI- NR
DPSA3	DIAMOND CK - PEACH SPRINGS- NR
SEMA3	SPENCER CK - PEACH SPRINGS- NR

\*All are in Lake Mead Local Drainage

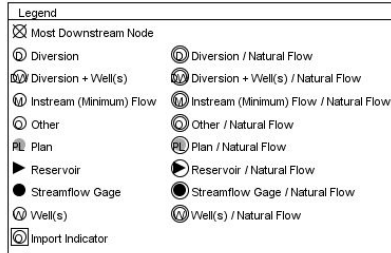
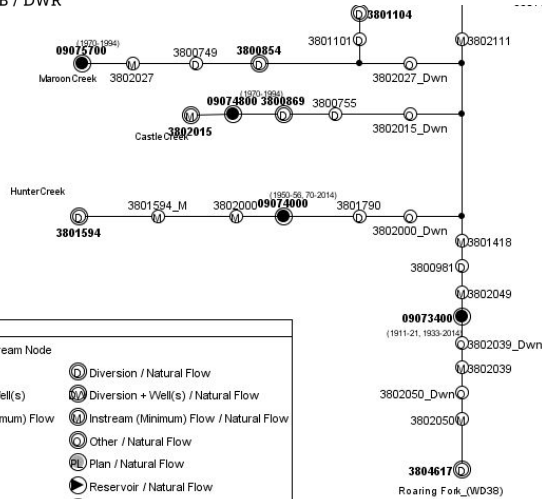
# CBRFC Consumptive Use Model Calibration

Software and historical data from the State of Colorado was used to parameterize the CBRFC Consumptive Use Model:  
-irrigated acreage, efficiency, demand, return flow



**COLORADO'S**  
Decision Support Systems  
CWCB / DWR

StateDMI  
StateCU



Upper Colorado River Basin  
Water Resources Planning Model  
User's Manual



July 2016

COLORADO'S  
DECISION SUPPORT SYSTEMS



**Table 5.6**  
Direct Flow Diversion Summary Average  
1975-2013

#	Model ID	Name	Capacity (cfs)	2010 Irrigated Acreage	Average System Efficiency (%)	Average Annual Demand (af)
1	3600507	ALBER DITCH	11	37	21	756
2	3600603	ED WARD DITCH	17	42	20	1,033
3	3600606	ELLIOTT CREEK FEEDER <sup>2</sup>	112	0	0	0
4	3600642	GREEN MOUNTAIN CANAL	43	84	19	2,950
5	3600645	GUTHRIE THOMAS DITCH	38	569	36	5,293
6	3600649_D	HAMILTON DAVIDSON DIVSYS	100	702	18	11,461
7	3600658	HIGHLINE DITCH	12	46	10	907
8	3600660	HIGH MILLER DITCH	32	141	13	3,602
9	3600662_D	HOAGLAND DIVSYS	91	1,014	26	9,976
10	3600671	INDEPENDENT BLUE DITCH	40	28	4	3,120
11	3600687	KIRKWOOD DITCH	17	24	13	1,279

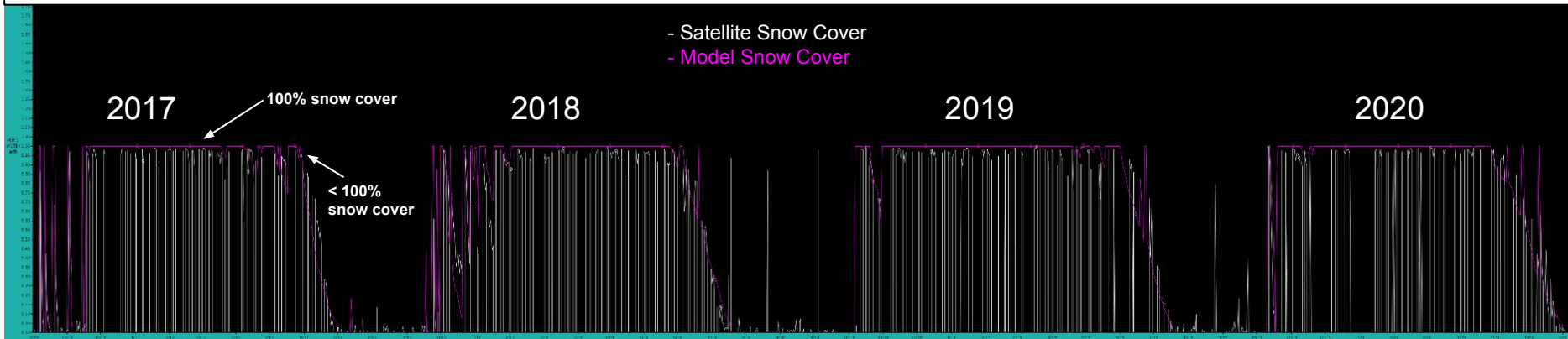
# CBRFC Consumptive Use Model Calibration

- Why we did this
  - To more accurately model the thousands of unmeasured depletions that occur across western Colorado
    - Now making fewer assumptions related to irrigated acreage in our model
    - General but more accurate assumptions still being made related to irrigation efficiency & return flow
  - Increased forecast/model transparency based on a reliable and well maintained dataset
- Implications/Impacts
  - Will be reflected in ESP traces
    - Example: If modeled unmeasured depletions increased -> ESP volume decreases
- We are working on analyzing/quantifying the differences in our modeled unmeasured depletions pre vs. post model recalibration.
- CBRFC is involved in a project that will help us transition to ingesting more real-time consumptive use data/trends from Colorado's Decision Support Systems directly into our hydrologic model

# CBRFC Snow Model Calibration

- Collected/processed/used historical (2000-2020) satellite data (snow covered area) during snow model calibration.
- Useful for better understanding basin elevation zone melt rate patterns from year to year and snow coverage trends (north vs. south facing slopes)
  - Helped fine tune snow model areal depletion curve and improve model snowmelt timing

Example: above Dillon Reservoir along Continental Divide  
11,000' model (TCFC2) snow covered area vs. satellite snow covered area



# SNOTEL Additions to CBRFC Model Calibration

- CBRFC collects and evaluates weather station (precipitation/temperature) data during our hydrologic model recalibration process.
- Depending on the gage coverage/density/period of record in a region, new weather stations are used during the calibration process:
  - To estimate nearby missing gage data
  - Weighted to generate basin zone mean areal precip/temp forcings

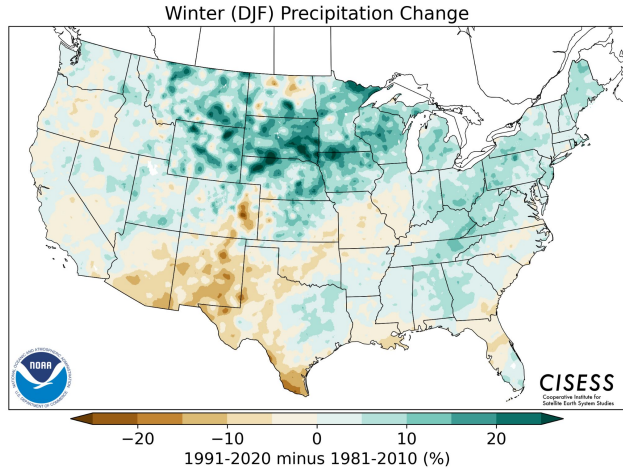
## New Snotels for 2020

Little Snake River	LITW4	I	16	White-Yampa
Sharkstooth	SKZC2	I	16	Dolores, San Juan
Ivanhoe	IVHC2	I	29	Upper Colorado
Beaver Ck Village	BCVC2	I	17	Upper Colorado
McCoy Park	MCYC2	I	18	Upper Colorado
New Fork Lake	NFLW4	I	35	Upper Green
Loveland Basin	LBAC2	O	28	Upper Colorado
Jones Pass	JNPC2	I	21	Upper Colorado
Middle Fork Camp	MFKC2	I	19	Upper Colorado
Arapaho Ridge	ARPC2	I	18	Upper Colorado
Buffalo Park	BUFC2	I	25	Upper Colorado, White-Yampa
Bear River	BRRC2	I	16	Upper Colorado, White-Yampa
Lost Dog	LOTC2	I	22	White-Yampa
Gunsight Pass	GUNW4	I	22	Upper Green
Weminuche Creek	WMNC2	I	10	San Juan
Chapman Tunnel	HAPC2	I	12	Upper Colorado
Jackwhacker Gulch	JWGC2	O	21	Upper Colorado
Michigan Creek	MIHC2	O	21	Upper Colorado

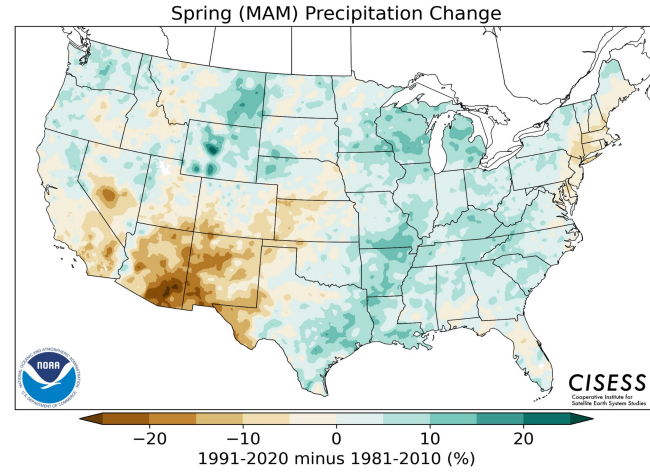


# New Normals: Precipitation/Temperature Change

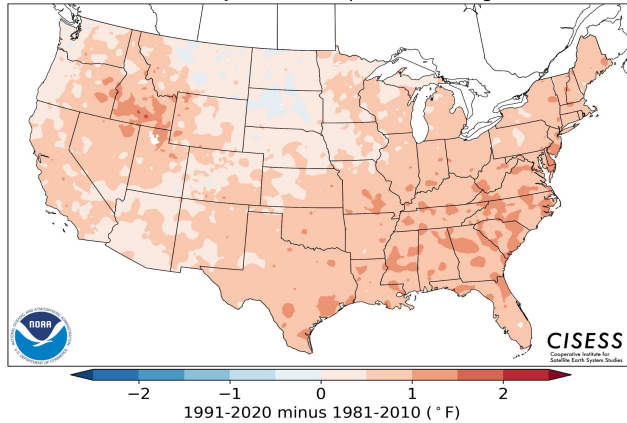
Winter: Dec-Jan-Feb



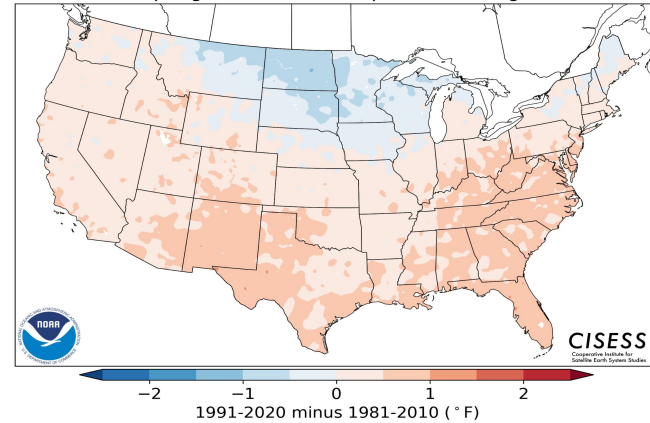
Spring: Mar-Apr-May



Winter (DJF) Mean Temperature Change



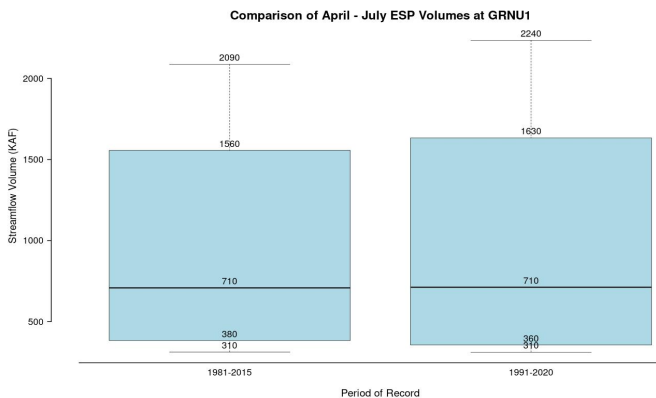
Spring (MAM) Mean Temperature Change



# CBRFC New Normals: ESP Impacts

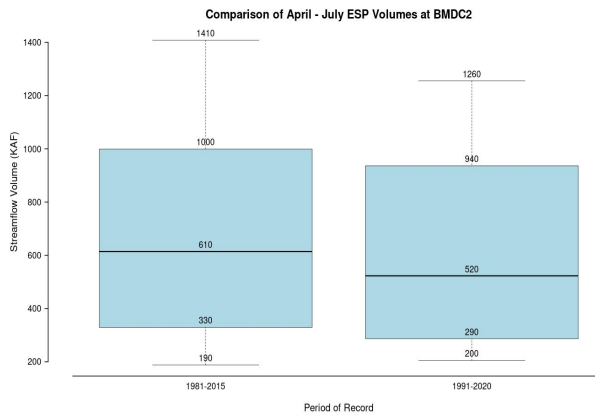
- Transition to 1991-2020 period on Oct 1st
  - All forecasts are being developed on 1991-2020 forcings
  - All observed/model data is now being compared to 1991-2020
  - ESP Impacts:
    - Minor changes in northern basins
    - Larger changes (drier) in southern basins

## Flaming Gorge



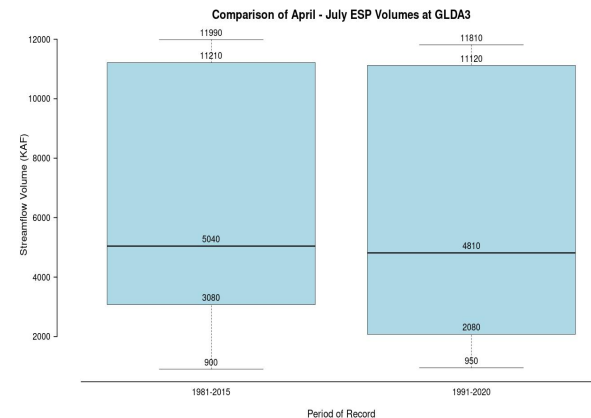
Observed Unregulated Volume  
1981-2010: 979 kaf  
1991-2020: 966 kaf  
1.3% decrease

## Blue Mesa



Observed Unregulated Volume  
1981-2010: 676 kaf  
1991-2020: 636 kaf  
5.9% decrease

## Lake Powell



Observed Unregulated Volume  
1981-2010: 7155 kaf  
1991-2020: 6392 kaf  
10.7% decrease

# CBRFC Soil Moisture Documentation

## Soil Moisture Modeling and Monitoring by CBRFC

The Colorado Basin River Forecast Center utilizes the Sacramento Soil Moisture Accounting (Sac-SMA) hydrologic model (Burnash et al., 1973) within its operational modeling system. Sac-SMA is a conceptual model that attempts to represent soil moisture characteristics to effectively simulate runoff that may become streamflow in a channel.

This document is intended to provide background information about the soil moisture parameters used in operational hydrologic modeling at CBRFC, to describe how Sac-SMA is tailored to CBRFC's modeling and forecasting environment, and how information generated by Sac-SMA is used by CBRFC hydrologists.

### Overview of Sac-SMA Model

#### Types of Runoff Simulated by Sac-SMA

Sac-SMA can simulate six types of runoff, which can be divided into two categories: fast and slow.

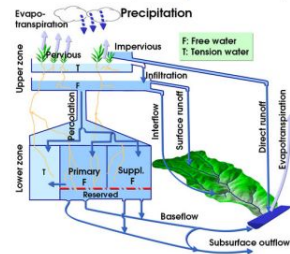
In fast-response events, water gets to the channel within hours of the water input event (rainfall and/or snowmelt). Types of fast-response runoff include:

- **intensity-dependent surface runoff:** generated from unsaturated soils in (1) pervious areas and (2) areas of which a fraction may be impervious
- **impervious runoff:** generated from areas that are always impervious (e.g., heavily urban areas)
- **direct runoff:** generated from the saturated portion of an area

Sac-SMA also simulates slow-response processes, in which water takes days or years to reach a stream channel. Within Sac-SMA, these slow-response processes are available only to modeling units that contain pervious areas. The slow-response processes available within Sac-SMA include:

- **interflow:** drains in days to a week
- **supplemental baseflow:** drains in weeks to two months after a water input event
- **primary baseflow:** drains in months to years and sustains streams in dry periods.

Figure 1 shows a schematic of the Sac-SMA model, including the runoff components described above.



Home Rivers Snow **Water Supply** Reservoirs Weather Climate Help About News

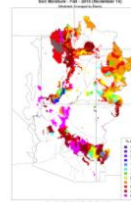
Our model is currently being updated.

### Fall Soil Moisture Griddeck

- [Help - About these maps.](#)
- [Help - About Soil Moisture.](#)
- [Help - About the Sac-SMA Model.](#)

Type: Calibration (1980-2014)  
Area: CBRFC Upper Colorado

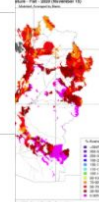
2015 [Data File](#)



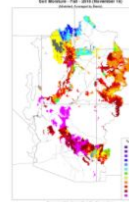
2018 [Data File](#)



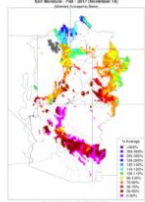
[Data File](#)



2016 [Data File](#)



2017 [Data File](#)



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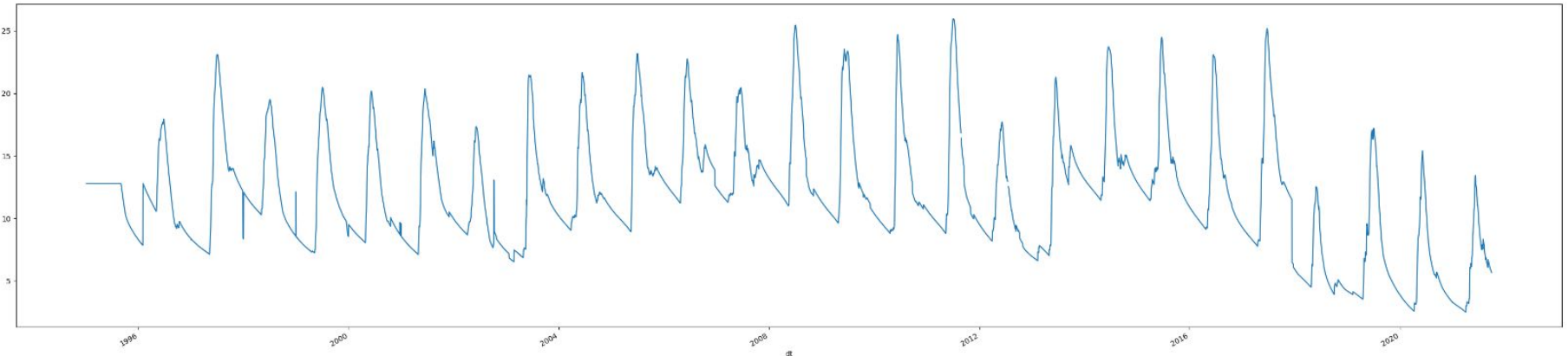
# CBRFC Multi-Year Model Soil Moisture Graphics

Goals:

- Provide stakeholders/users with a better understanding of CBRFC hydrologic model soil moisture conditions (states) that impact streamflow forecasts
- Visualize soil moisture trends at various time scales

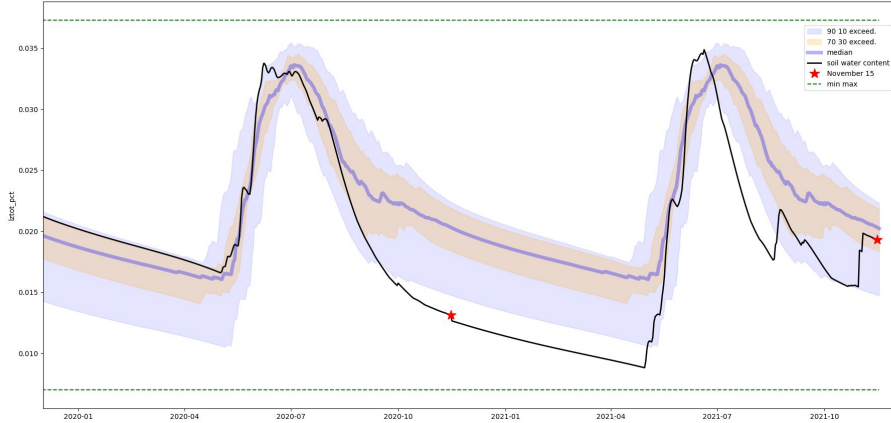
Currently in early development stages

**Example: 25-year lower soil zone plot**



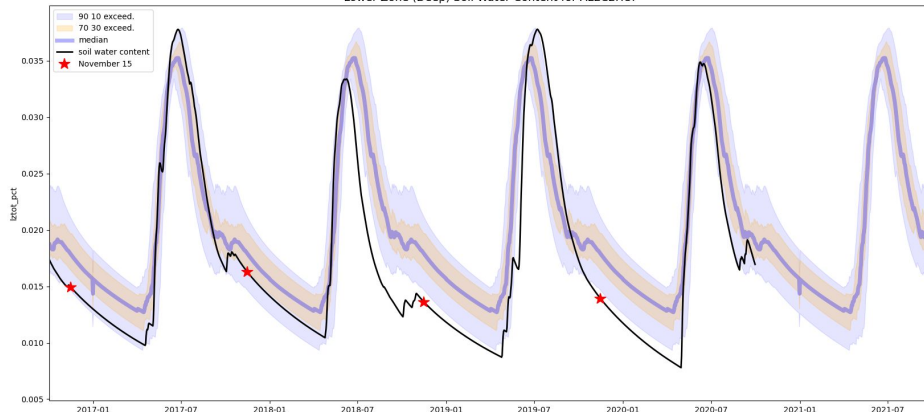
# CBRFC Multi-Year Model Soil Moisture Graphic Examples

Lower Zone (Deep) Soil Water Content for FRAW4HUF



2- and 5-year soil moisture plots with exceedance bounds, min, max, median.

Lower Zone (Deep) Soil Water Content for ALEC2HUF



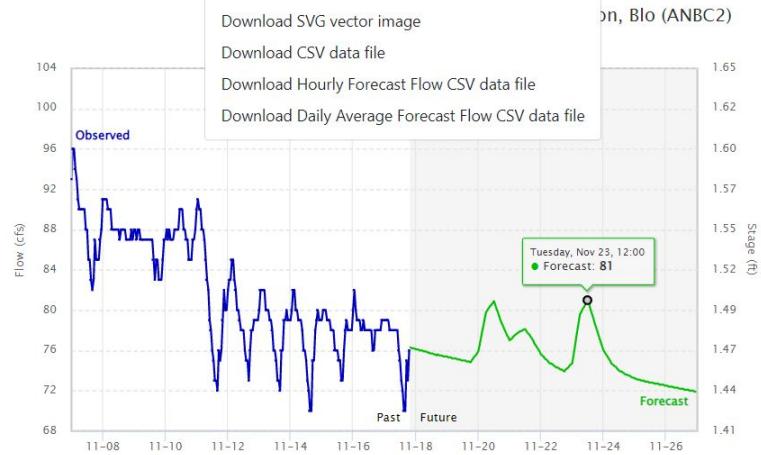
What kind of CBRFC model soil moisture information do you want to see?

# 10-Day Streamflow Forecast Hydrograph - River

## ANBC2 - Animas - Silverton, Blo

[Related Plots](#) | 
 [Point Info](#) | 
 [Downloads](#) | 
 [Show Data Table](#) | 
 [Select Current Observed](#) | 
 [Select Forecast Peak](#)

- Download PNG image
- Download SVG vector image
- Download CSV data file
- Download Hourly Forecast Flow CSV data file
- Download Daily Average Forecast Flow CSV data file



- Simulated
- Observed
- Forecast
- ▲ Daily Maxima
- 25-10% Hist Exceedance
- 50-25%
- 75-50%
- 90-75%

- Options**
- Linear Flow Scale ⓘ
  - Zero Flow Minimum Scale
  - Scale to Critical Stages ⓘ
  - Scale to Historical Peak
  - Simulated
  - Daily Maxima
  - Historical Exceedance
  - Probabilistic Forecast ⓘ

Forecast Created: 2021-11-17 15:00Z  
 Forecast Peak: 1.50 ft, 81 cfs (11/23/12Z)  
 Flood: NA - Action: NA  
 Current: 1.47 ft, 77 cfs (11/17/19Z)  
 Page Created: 2021-11-17 19:33Z

**Begin Date**

**End Date**

More interactive -> hover for values  
 Data Table Option  
 Forecast Peak Option  
 Historical Exceedance  
  
 Feedback is welcome

UTC	Observed	Forecast
2021-11-07 00:00:00	93	
2021-11-07 01:00:00	96	
2021-11-07 02:00:00	96	
2021-11-07 03:00:00	94	
2021-11-07 04:00:00	93	



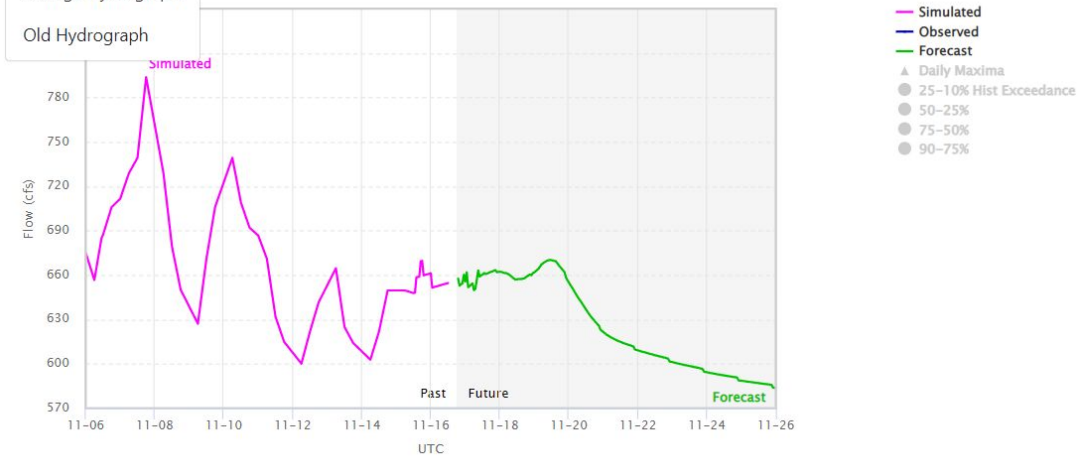
# 10-Day Streamflow Forecast Hydrograph - Reservoir

## GBRW4 - Green - Fontenelle Reservoir, Fontenelle, Nr

Related Plots Point Info Downloads Show Data Table Select Current Observed Select Forecast Peak

- Inflow Hydrograph
- Outflow Hydrograph
- Storage Hydrograph
- Old Hydrograph

Reservoir Inflow Hydrograph - Green - Fontenelle Reservoir, Fontenelle, Nr (GBRW4)  
Colorado Basin River Forecast Center



Forecast Created: 2021-11-16 15:00Z  
Forecast Peak: 0.00 ft, 670 cfs (2021-11-19 11:00)  
Flood: NA - Action: NA  
Current: NA  
Page Created: 2021-11-16 18:31Z

**Begin Date**  
11/06/2021

**End Date**  
11/26/2021

- Options**
- Linear Flow Scale
  - Zero Flow Minimum Scale
  - Scale to Critical Stages
  - Scale to Historical Peak
  - Simulated
  - Daily Maxima
  - Historical Exceedance
  - Probabilistic Forecast

# Summary

- Recent model recalibration was an enormous effort during a time of telework, a busy monsoon season, and employee transition
- CBRFC hydrologic model calibration/development is a continuous process that includes decades of forecaster knowledge & experience
  - ~15 new forecast locations implemented across the Upper Colorado River Basin in 2021
  - Implemented the most comprehensive historical consumptive use dataset in Western CO within our model/streamflow forecasting operations
  - Standardized model elevation zone breaks across western CO
  - Included satellite (observed) snow cover during snow model calibration
- New normals - analysis, trends
  - 1991-2020 volumes are less than 1981-2010 volumes (on average)
  - Magnitude of volume decreases increase from north to south
  - Lake Powell ~10% lower
- Soil moisture
  - Improved documentation on our webpage
  - Working on ideas/graphics to better visualize and communicate how soil moisture impacts streamflow forecasts
- Updated 10-day streamflow forecast hydrographs
  - More interactive/intuitive/readable



# CBRFC Water Supply Forecast Point Changes

- Dropping mainstem San Juan forecasts
  - Significant unmeasured depletions; unreg ESP doesn't make sense
    - San Juan - Farmington
    - San Juan - Bluff
- Dropping Plateau Creek near Cameo (PCCC2) water supply forecast point
  - Observed real-time diversion data is not available
  - Forecast skill/verification has been poor
    - Reach has 60+ unmeasured diversions
- Dropping Paonia Reservoir (PRSC2) March-June official forecast period
  - April-July official forecast period
  - Monthly forecasts will continue to be provided for this location

# CBRFC Basin Focal Points/Contacts

## **Basin Focal Points (Forecasters)**

Brenda Alcorn - Green, Duchesne, White/Yampa

[brenda.alcorn@noaa.gov](mailto:brenda.alcorn@noaa.gov)

Ashley Nielson – Gunnison, San Juan, Dolores, Lake Powell

[ashley.nielson@noaa.gov](mailto:ashley.nielson@noaa.gov)

Cody Moser – Upper Colorado Mainstem

[cody.moser@noaa.gov](mailto:cody.moser@noaa.gov)

Patrick Kormos – Great Basin

[patrick.kormos@noaa.gov](mailto:patrick.kormos@noaa.gov)

Trevor Grout - Virgin, Lower Colorado

[trevor.grout@noaa.gov](mailto:trevor.grout@noaa.gov)

Brent Bernard – Hydrologist

[brent.bernard@noaa.gov](mailto:brent.bernard@noaa.gov)

Tracy Cox - Hydrometeorologist

[tracy.cox@noaa.gov](mailto:tracy.cox@noaa.gov)

**+2 new forecasters arriving soon!**

Michelle Stokes – Hydrologist In Charge

[michelle.stokes@noaa.gov](mailto:michelle.stokes@noaa.gov)

Paul Miller– Service Coordination Hydrologist

[paul.miller@noaa.gov](mailto:paul.miller@noaa.gov)

John Lhotak – Development and Operations Hydrologist

[john.lhotak@noaa.gov](mailto:john.lhotak@noaa.gov)

CBRFC Webpage  
<https://www.cbrfc.noaa.gov/>

CBRFC Operations  
[cbrfc.operations@noaa.gov](mailto:cbrfc.operations@noaa.gov)  
801-524-4004

