CBRFC Water Year in Review

An Overview of Operational Changes, Improvements, and Investigations over the course of Water Year 2022

August, 2023

National Oceanic and Atmospheric Administration (NOAA)

National Weather Service (NWS)

Colorado Basin River Forecast Center (CBRFC)

Table of Contents

1 INTRODUCTION

1.1 Purpose

This document, an annual product from the Colorado Basin River Forecast Center (CBRFC), describes the forecasting activities, research, and improvements undertaken by the CBRFC over the course of Water Year 2022. An overview of the climate and significant weather events and patterns are presented to provide context regarding the CBRFC's forecasts, with particular emphasis on volumetric water supply forecasts and efforts to improve those forecasts, especially in response to stakeholder needs.

The activities and results presented here are intended to be comprehensive, and some may be of interest to a narrow range of stakeholders. As such, any omissions are inadvertent, but may be incorporated into a future version of this document if the need arises.

1.2 Water Year 2022 Climate and Significant Weather Events

Persistent drought conditions dating back to 2000 have driven hydroclimatic conditions over the Colorado River Basin to historically dry conditions, and continued dry conditions over Water Year 2022 exacerbating strained water resources throughout much of the basin. Notably, the combined reservoir storage between Lake Powell and Lake Mead fell to 26% capacity by the end of Water Year 2022, the lowest combined storage since Lake Powell was initially filled in 1980 (Figure 1).

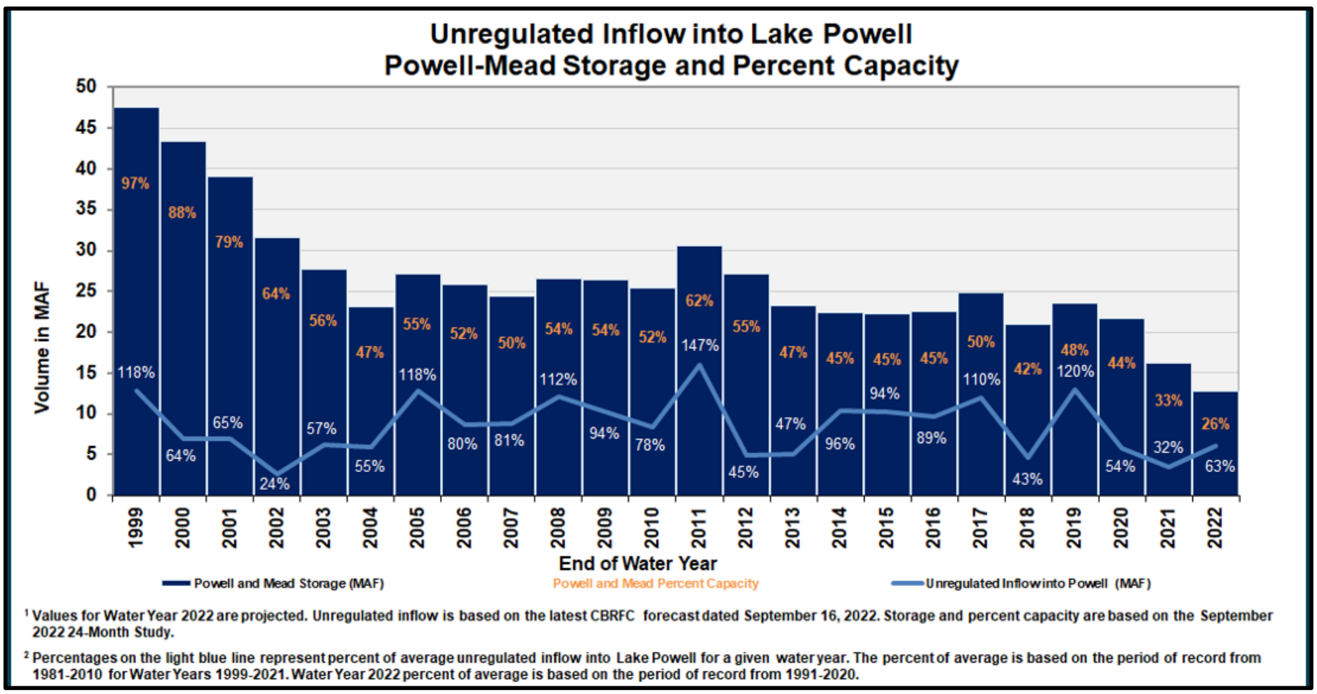

Figure 1: This figure, from the Bureau of Reclamation's Lower Colorado Region's Boulder Canyon Operations Office, shows the combined reservoir storage between Lake Powell and Lake Mead in blue columns. The percent capacity between the two reservoirs is in orange type. Unregulated inflow values, developed by the CBRFC, are illustrated in the light blue line with associated white text as a percent of the 1991-2020 average.

Water Year 2022 precipitation and streamflow conditions tended to be below average over most areas in the Upper Colorado River Basin; however, precipitation amounts from June through September 2021 were generally above average, particularly in the Lower Colorado River Basin which experienced one of the wetter monsoon seasons on record. As such, Fall 2021 soil moisture conditions were improved from 2020's historically dry conditions, though still below average (Figure 2). Dry antecedent soil moisture conditions result in decreased runoff efficiency; an analysis by the CBRFC indicated that each 1.0% decrease in fall soil moisture conditions reduced annual runoff volume by approximately 0.5%[1].

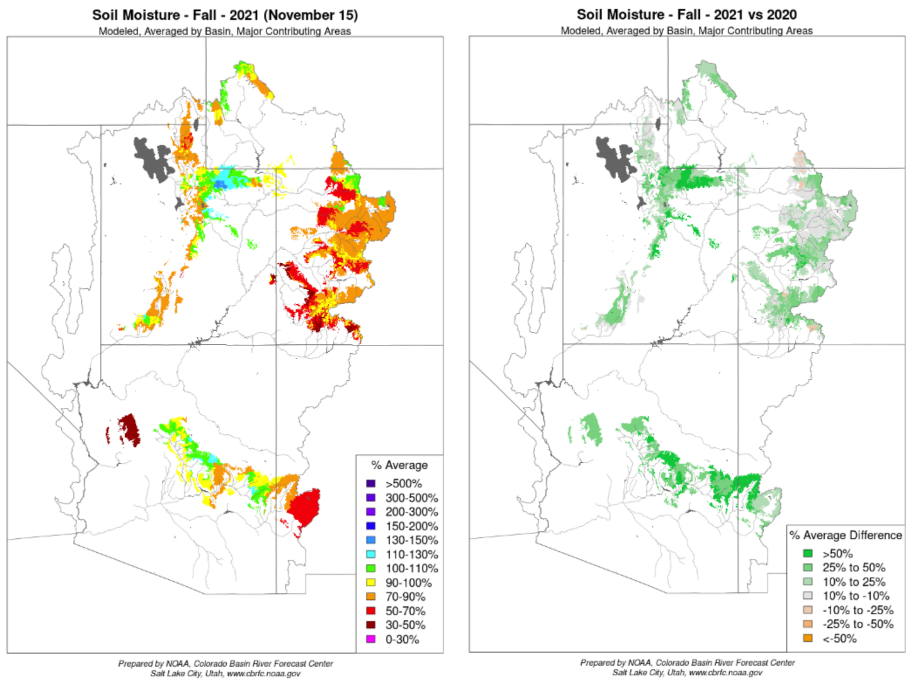

Figure 2: Generally improved, but still below average, Fall 2022 (November 15) soil moisture conditions were present throughout the CBRFC's area of responsibility. Dry soil moisture conditions decrease seasonal and annual runoff efficiency.

Water Year 2022 snowpack conditions were above normal throughout most of the Upper Colorado River Basin and Great Basin by January 1st, with drier conditions in the Green River Basin being an exception (Figure 3). SNOwpack TELemetry (SNOTEL) stations maintained by the Natural Resources Conservation Service (NRCS) indicated near normal to above normal (median) snow water equivalent (SWE) values reported over central Utah, Colorado Headwaters, Gunnison River Basin and

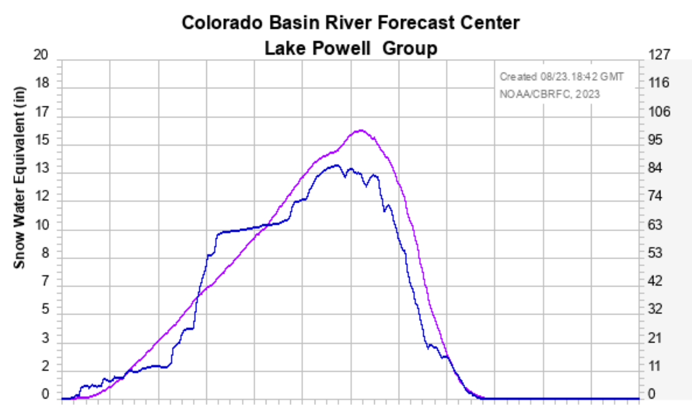

Figure 3: Aggregated snowpack conditions (blue line) compared to median conditions (purple line) above Lake Powell for water year 2022.

[1] See the CBRFC's Model Sensitivity Analysis, October 2020. Available at: https://www.cbrfc.noaa.gov/report/CBRFC_Model_Sensitivity_Analysis_2020.pdf

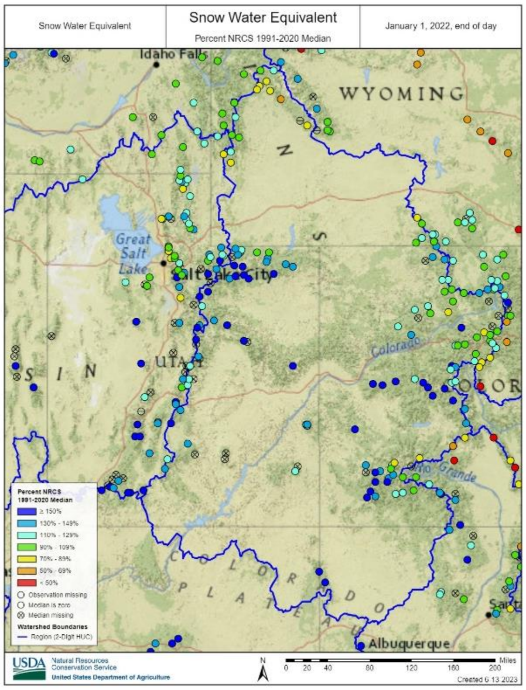

Figure 4: SWE values at NRCS SNOTEL locations throughout the Upper Colorado River Basin. Most values ranged from 60% to 80% of normal (median) on January 1st, 2022.

San Juan River Basin (Figure 4). However, by April, water year to date precipitation was below average throughout the CBRFC's area of responsibility (Figure 6). Model precipitation values were typically between 70% to 90% of average throughout the Upper Colorado River Basin and Great Basin regions; drier conditions were prevalent throughout the Lower Colorado Basin as model precipitation amounts rarely exceeded 50% of average.

1.2.1 A Short-Lived Average Start to the Year

Despite a near average start to the water year, precipitation events from January through April curtailed sharply and precipitation amounts were below normal throughout much of the basin. Over the period spanning January 1, 2022 through April 30, 2022, SNOTEL locations throughout the Upper Colorado River Basin and Great Basin received precipitation amounts below the 15th percentile of the historical record, and many sites reported record dry or near record dry conditions (Figure 5).

Precipitation is the primary driver of CBRFC water supply forecasts; as a result of the dry late winter and early spring, water supply volumes that were generally forecasted near average in January ultimately were realized closer to 50% to 60% of average. The unregulated April through July volume at Lake Powell was 3.75 million acre-feet (MAF) for 2022 (Figure 7).

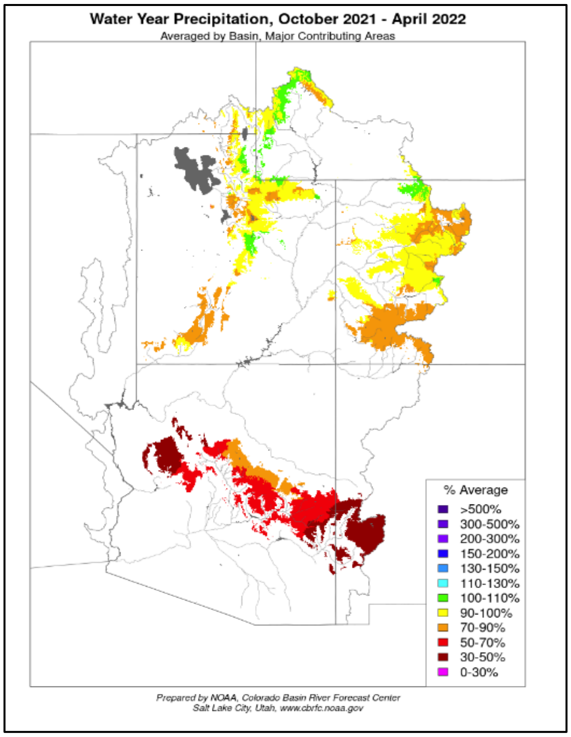

Figure 6: Water Year precipitation values through April over significant streamflow producing areas were below average.

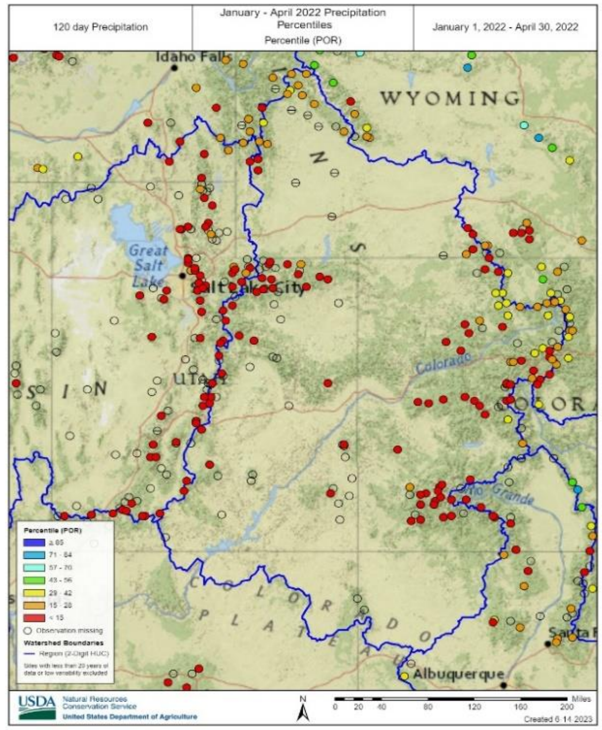

Figure 5: Precipitation amounts throughout the Colorado River Basin from January through April were generally in the bottom 15th percentile of the historical record. Many gages recorded the driest amount over their period of record.

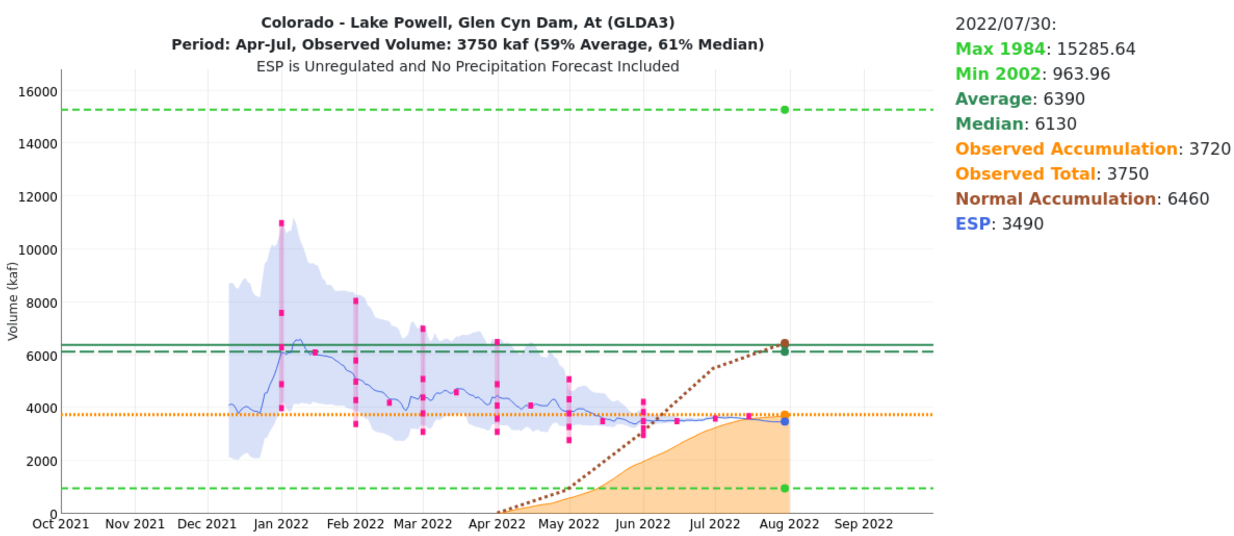

Figure 7: An initial forecast near average was not sustainable as dry conditions prevailed over the course of the calendar year. Unregulated streamflow values were below average throughout the CBRFC's area of responsibility.

1.2.2 An Impactful Monsoon Season

The 2022 monsoon was active, particularly over southeastern Arizona and western New Mexico with precipitation occurring over 70% of the time over the period from June 15 through September 30 (Figure 8). Much above average precipitation amounts were apparent throughout Arizona and western New Mexico, especially in the area over the headwaters of the Gila River. Over the monsoon season, portions of the Gila River headwaters saw in excess of 15" of rain (in excess of 200% of average) (Figure 8).

1.2.2.1 August Flood Impacts over Gila River Basin

Over the course of the summer monsoon season, persistent, frequent, and intense rainfall events resulted in frequent, flood impacts over the Lower Colorado River Basin, particularly in southern Arizona and New Mexico. Most notably, major flooding occurred in and around the area of Duncan, Arizona on August 22nd and 23rd, as streamflow exceeded 20,000 cfs and river stages were measured in excess of 23 feet. Two issues led to increased CBRFC forecast uncertainty:

- Sparse data availability in areas near the headwaters of the Gila River with the most rainfall accumulation. This area of southeastern Arizona and southwest New Mexico is lacking both gage and radar coverage.

- Due to geomorphologic changes and vegetation growth in river channels and reaches that had been long unaffected by substantial rain and flow events, rating tables at United

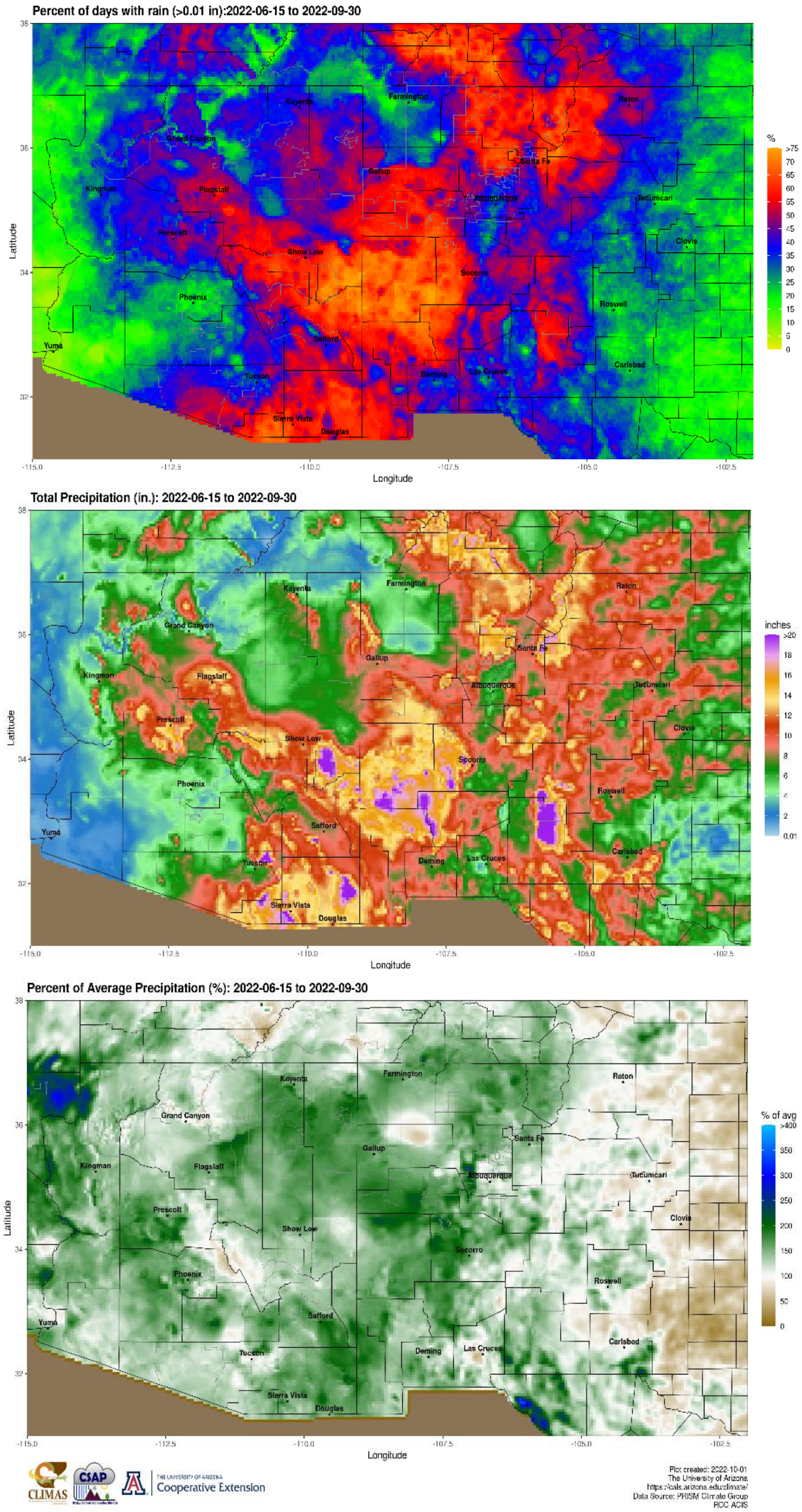

Figure 8: An active monsoon season brought frequent (top figure) precipitation events to the Lower Colorado River Basin. The middle figure shows the total precipitation observed over the monsoon season; the bottom figure shows these amounts as a percent of average..

States Geological Survey (USGS) gage locations and CBRFC forecast points were invalid, especially at these high flow values.

While forecasted stage values tended to be accurate during the early part of the event, flow associated with these stages were probably incorrect. CBRFC forecasters, WFO personnel in El Paso and Tucson, and USGS personnel in Las Cruces and Tucson communicated and worked together to obtain as much information as possible during the event to plan for downstream impacts. As a result of this event, the CBRFC began to work more closely with the USGS to develop a process to be notified when primary and backup sensors are swapped, develop an archive of high flow events, and work towards better conveying uncertainty in forecasts to WFOs when flows exceed or are at the extreme ends of a rating curve.

2 Summary of Major Water Year 2022 Improvements

The CBRFC constantly evaluates and works to improve its hydrologic model and methodology, including updating calibrations of specific forecast points when necessary. Additionally, there were several operational improvements at the CBRFC impacting a broad range of stakeholders that will be summarized here, and discussed in more detail in the sections that follow. This year, improvements have been broken down into the following categories:

- New and Enhanced Methods to Improve, Communicate, and Distribute Forecasts (Section 3)
- Research, Investigations, and Collaborations (Section 4)

Over the course of Water Year 2022, the CBRFC worked to improve forecasts, in part, through the implementation of updated bathymetric information for Lake Powell and the implementation of an improved consumptive use model based on recently completed research by RTI that was funded by the Bureau of Reclamation (Reclamation) and the Colorado River Climate and Hydrology Work Group (Work Group). The CBRFC improved dissemination methods, making 5-year forecasts available weekly, improving documentation, growing a social media presence, and working with the Natural Resources and Conservation Service (NRCS) to display water supply forecasts from both agencies on a single webpage. Further, the CBRFC engaged with the research community to investigate datasets and methods to improve the modeling of snow water equivalent (SWE) information throughout the CBRFC's area of responsibility.

3 New and Enhanced Methods to Improve, Communicate and Distribute Forecasts

3.1 Implementation of Alternative Unmeasured Depletion Modeling at Los Pinos River at La Boca, Colorado

The CBRFC recently collaborated with the Work Group and Research Triangle Institute International (RTI) to develop improved estimates of unmeasured depletions modeled within the CBRFC's hydrologic forecast development paradigm over the state of Colorado. Colorado was chosen due to its expansive and available water use data. Typically, unmeasured depletions within the CBRFC's hydrologic model are developed through the use of a "consumptive use" model that considers irrigated acreage and temperature as the primary drivers to develop an unmeasured depletion estimate for use in deriving a streamflow forecast. RTI developed a diversion and unmeasured depletion modeling framework using transformations available within the CBRFC's Community Hydrologic Prediction System (CHPS). The primary differences between the consumptive use model typically utilized by the CBRFC and the methodology developed by RTI are:

- The RTI derived methodology utilizes the Penman-Monteith method to estimate evaporative demand, rather than the Blaney-Criddle method used in the CBRFC's consumptive use model.
- The RTI derived methodology uses estimates of wind speed, vapor pressure, atmospheric pressure, solar radiation, and soil heat flux derived from observed and forecasted temperature values used to force the CBRFC's hydrologic model.

- The RTI derived methodology adjusts for irrigation demand satisfied by precipitation, whereas the CBRFC's consumptive use model does not.

The CBRFC implemented RTI's methodology for modeling unmeasured depletions for forecasts at the Los Pinos River at La Boca, Colorado (LOSC2) gage and is currently evaluating the impact. It should be noted that this research represents the completion of Phase 1 of an initially proposed five phase project; the Work Group is currently evaluating options for funding future phases of this project that have been revised based on newly available data and the results of this initial phase.

3.2 Incorporation of New Lake Powell and Flaming Gorge Bathymetry

The USGS, in cooperation with Reclamation, developed an updated bathymetric profile of Lake Powell in March. Similarly, Reclamation developed an updated bathymetric profile of Flaming Gorge in November. This necessitated an update to storage elevation curves utilized by both Reclamation and the CBRFC for both reservoirs. The CBRFC incorporated the updated storage elevation curves in July. The USGS report detailing the derivation of the updated bathymetric profile for Lake Powell can be found here[2]. The Reclamation report detailing the derivation of the updated bathymetric profile for Flaming Gorge can be found here[3].

3.3 Development of Updated CBRFC Reforecasts for Reclamation

The CBRFC underwent an extensive recalibration of its hydrologic model in 2021. Reforecasts using the updated calibration and forcing hydrology spanning 1991 through 2020 were developed by the CBRFC for use by Reclamation in their reservoir planning models. For these reforecasts, initial conditions from each month spanning 1981 through 2020 (40 years X 12 months) were forced with precipitation and temperature spanning 1991 through 2020 (30 years corresponding with operational ensemble streamflow prediction runs). Water Year 2022 is the first year that the new 30-year normal period was implemented for operational forecasting.

CBRFC reforecasts are available upon request.

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[2] For those unable to use the hyperlink: https://www.usgs.gov/publications/elevation-area-capacity-relationships-lake-powell-2018-and-estimated-loss-storage

[3] For those unable to use the hyperlink: https://www.usbr.gov/tsc/techreferences/reservoir/FlamingGorgeRes2019SedimentationSurvey_final508.pdf

3.4 Weekly 5-Year Forecasts Made Available

The CBRFC has been developing ensemble forecasts spanning 5 years for use by Reclamation in its reservoir operations model. These forecasts were typically provided on a monthly basis and were adjusted to be consistent with water supply forecasts developed by the CBRFC with short lead times. The Colorado River Authority of Utah (CRAU) requested that 5-year forecasts be made available on a weekly basis for use in their hydrologic modeling efforts. The CBRFC was able to accommodate this request; however, these forecasts are not adjusted to be consistent with other water supply forecasts developed by the CBRFC. Additionally, the CBRFC is not able to review or provide quality control for these weekly 5-year forecasts. These forecasts are available here[4].

3.5 Implementation of HEFS forecasts

The Hydrologic Ensemble Forecasting System (HEFS) is currently being developed by the NWS with the goal of providing probabilistic, short-term streamflow forecasts across the country. The primary benefit of utilizing HEFS is to leverage the meteorologic uncertainty associated with forecasts by using the ensemble mean from the Global Ensemble Forecast System (GEFS) version 12. Hindcasts from the GEFS ensemble mean are compared to historical observations of precipitation and temperature; from these comparisons, statistical relationships are developed to compute calibrated forcing parameters for the CBRFC's hydrologic model from the GEFS forecast. Currently, HEFS products utilize quantitative precipitation forcings developed from the HEFS through use of the GEFS output for days 1 through 14. It should be noted that this methodology differs significantly from the CBRFC's paradigm for developing short-term deterministic forecasts; as such, when comparing the CBRFC's deterministic output to the CBRFC's probabilistic HEFS output, there may be significant differences, particularly in drier areas over the Lower Colorado River Basin.

Figure 9 shows a HEFS forecast product developed by the CBRFC. The deterministic forecast does not fall in the middle of the HEFS probabilistic forecast as one might intuitively expect. This is due to the different methodologies used in creating these forecasts.

[4] For those unable to use the hyperlink: https://www.cbrfc.noaa.gov/outgoing/crau/index.php

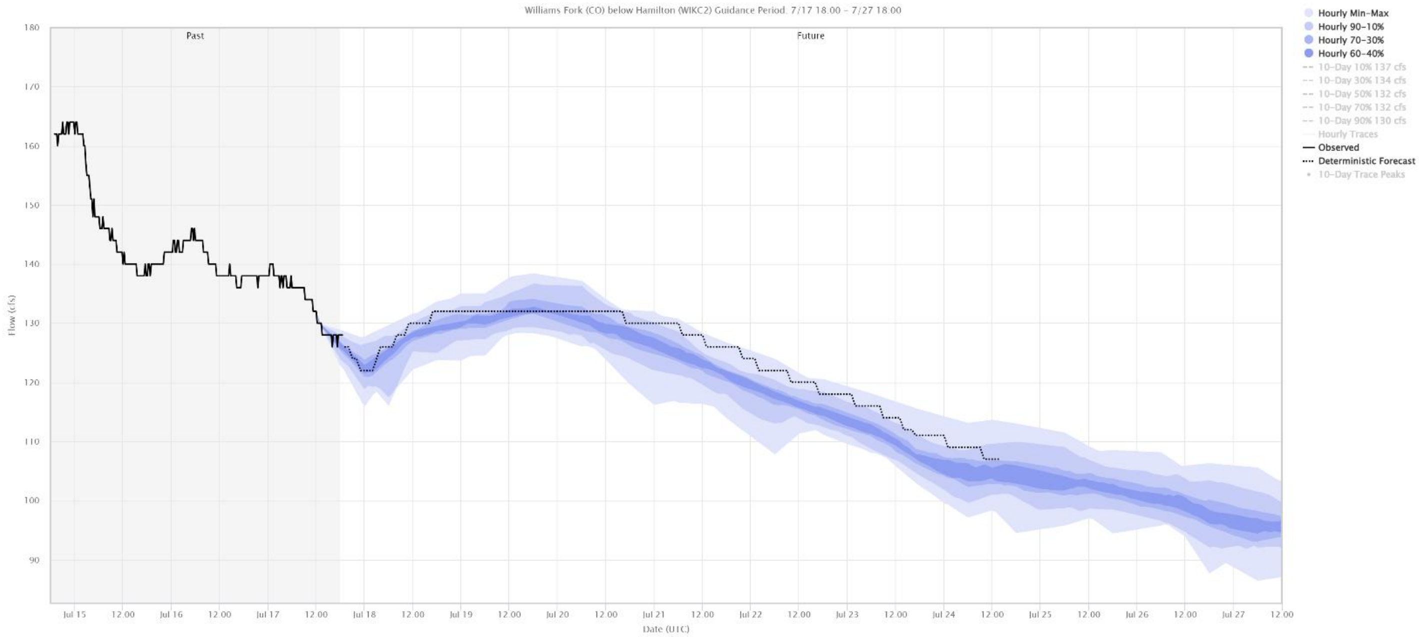


Figure 9: This plot illustrates a short term probabilistic forecast at Williams Fork below Hamilton, CO (WIKC2) in blue shading. The CBRFC's deterministic forecast is shown as a dotted black line. These plots are available through the CBRFC's website.

The CBRFC is currently hosting an experimental webpage aggregating the HEFS output from RFCs nationwide. It is important to note that the methodology behind the development of HEFS output differs between RFCs. The experimental website hosting nationwide HEFS output can be found here[5].

The CBRFC is working with partners at WFOs whose areas are within the CBRFC's area of responsibility to make HEFS forecast products available at the National Weather Service's Advanced Hydrologic Prediction Service (AHPS) webpage[6]. Some sites may not be available due to unreliable results from HEFS.

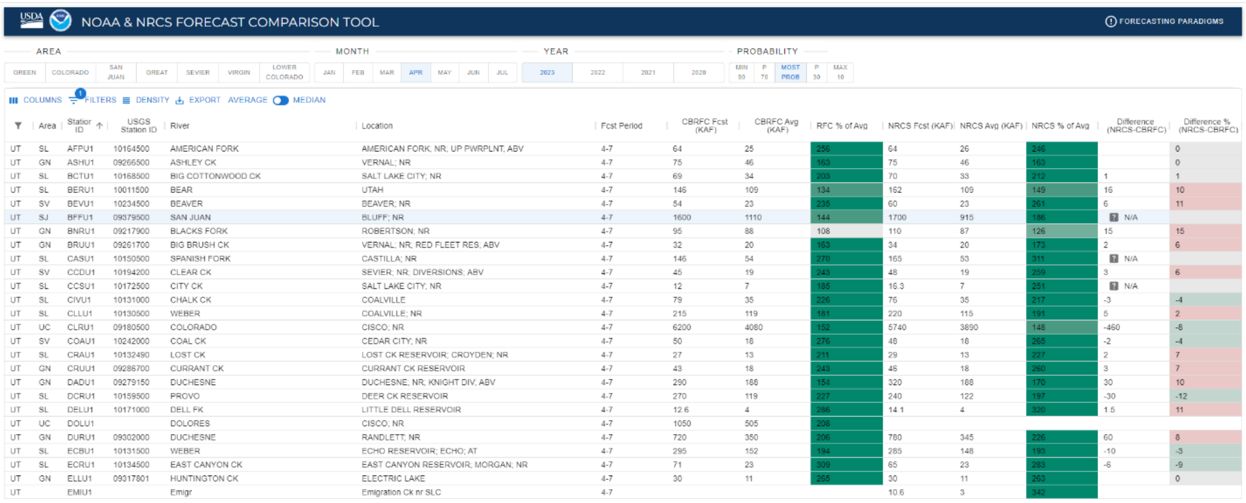
3.6 Development of NRCS and CBRFC Forecast Webpage

The NRCS develops and provides water supply forecasts throughout the Colorado River Basin that are utilized by stakeholders throughout the basin. These forecasts, at times, overlap with forecasts developed by the CBRFC. Similarly, the CBRFC develops forecasts at points not forecasted by the NRCS, and vice versa. Over a decade ago, the CBRFC and NRCS would coordinate seasonal water supply forecasts at shared locations; however, as methodologies at both agencies began to evolve and diverge, meaningful coordination on the forecasts without losing information from both agencies became impractical.

In response to a request by the NRCS, the CBRFC worked with the NRCS to create a unified landing page where both CBRFC and NRCS forecasts could be displayed and compared where

[5] For those unable to use the hyperlink: https://www.cbrfc.noaa.gov/dbdata/station/ensgraph/map/ensmap.html
[6] For those unable to use the hyperlink: https://water.weather.gov/ahps/forecasts.php

forecast information overlapped. This webpage is available here[7]. Figure 10 shows a snapshot of this page.



NOAA & NRCS FORECAST COMPARISON TOOL

FORECASTING PARADIGMS

AREA: GREEN | COLORADO | SAN JUAN | GREAT | SEVIER | VIRGIN | LOWER COLORADO

MONTH: JAN | FEB | MAR | APR | MAY | JUN | JUL

YEAR: 2023 | 2022 | 2021 | 2020

PROBABILITY: MIN 90 | P 70 | MOST PROB | P 30 | MAX 10

COLUMNS FILTERS DENSITY EXPORT AVERAGE MEDIAN

	Area	Station ID	USGS Station ID	River	Location	Fcst Period	CBRFC Fcst (KAF)	CBRFC Avg (KAF)	RFC % of Avg	NRCS Fcst (KAF)	NRCS Avg (KAF)	NRCS % of Avg	Difference (NRCS-CBRFC)	Difference % (NRCS-CBRFC)
UT	SL	AFPU1	10164500	AMERICAN FORK	AMERICAN FORK; NR; UP PWRPLNT; ABV	4-7	64	25	256	64	26	246		0
UT	GN	ASHU1	09266500	ASHLEY CK	VERNAL; NR	4-7	75	46	163	75	46	163		0
UT	SL	BCTU1	10168500	BIG COTTONWOOD CK	SALT LAKE CITY; NR	4-7	69	34	203	70	33	212	1	1
UT	SL	BERU1	10011500	BEAR	UTAH	4-7	146	109	134	162	109	149	16	10
UT	SV	BEVU1	10234500	BEAVER	BEAVER; NR	4-7	54	23	235	60	23	261	6	11
UT	SJ	BFFU1	09379500	SAN JUAN	BLUFF; NR	4-7	1600	1110	144	1700	915	186	N/A	
UT	GN	BNRU1	09217900	BLACKS FORK	ROBERTSON; NR	4-7	95	88	108	110	87	126	15	15
UT	GN	BRUU1	09261700	BIG BRUSH CK	VERNAL; NR; RED FLEET RES; ABV	4-7	32	20	163	34	20	173	2	6
UT	SL	CASU1	10150500	SPANISH FORK	CASTILLA; NR	4-7	146	54	270	165	53	311	N/A	
UT	SV	CCDU1	10194200	CLEAR CK	SEVIER; NR; DIVERSIONS; ABV	4-7	45	19	243	48	19	259	3	6
UT	SL	CCSU1	10172500	CITY CK	SALT LAKE CITY; NR	4-7	12	7	185	16.3	7	251	N/A	
UT	SL	CIVU1	10131000	CHALK CK	COALVILLE	4-7	79	35	226	76	35	217	-3	-4
UT	SL	CLLU1	10130500	WEBER	COALVILLE; NR	4-7	215	119	181	220	115	191	5	2
UT	UC	CLRU1	09180500	COLORADO	CISCO; NR	4-7	6200	4080	152	5740	3890	148	-460	-8
UT	SV	COAU1	10242000	COAL CK	CEDAR CITY; NR	4-7	50	18	276	48	18	265	-2	-4
UT	SL	CRAU1	10132490	LOST CK	LOST CK RESERVOIR; CROYDEN; NR	4-7	27	13	211	29	13	227	2	7
UT	GN	CRUU1	09286700	CURRANT CK	CURRANT CK RESERVOIR	4-7	43	18	243	46	18	260	3	7
UT	GN	DADU1	09279150	DUCHESNE	DUCHESNE; NR; KNIGHT DIV; ABV	4-7	290	188	154	320	188	170	30	10
UT	SL	DCRU1	10159500	PROVO	DEER CK RESERVOIR	4-7	270	119	227	240	122	197	-30	-12
UT	SL	DELU1	10171000	DELL FK	LITTLE DELL RESERVOIR	4-7	12.6	4	286	14.1	4	320	1.5	11
UT	UC	DOLU1		DOLORES	CISCO; NR	4-7	1050	505	208					
UT	GN	DURU1	09302000	DUCHESNE	RANDLETT; NR	4-7	720	350	206	780	345	226	60	8
UT	SL	ECBU1	10131500	WEBER	ECHO RESERVOIR; ECHO; AT	4-7	295	152	194	285	148	193	-10	-3
UT	SL	ECRU1	10134500	EAST CANYON CK	EAST CANYON RESERVOIR; MORGAN; NR	4-7	71	23	309	65	23	283	-6	-9
UT	GN	ELLU1	09317801	HUNTINGTON CK	ELECTRIC LAKE	4-7	30	11	265	30	11	263		0
UT		EMIU1		Emigr	Emigration Ck nr SLC	4-7				10.6	3	342		

Figure 10: A snapshot of the NOAA and NRCS Forecast Comparison Tool.

[7] For those unable to use the hyperlink: https://www.cbrfc.noaa.gov/dbdata/station/info/nrcsCompare/

3.7 Added QPF Overlay to CBRFC Homepage

Gridded QPF data was made available as an overlay on the CBRFC's homepage map, and allows users to view QPF over the CBRFC's area of responsibility as it relates to short-term and seasonal forecasts, and other information available on the CBRFC's interactive map. QPF for days 1 through 7 is available, as well as information regarding the change in QPF since the last issuance. Figure 11 shows an example of the QPF grid overlay. Users will need to turn on the QPF overlay by selecting the "Forecast Precipitation" drawdown menu and checking the "Show" box. Users can then select a particular date and forecast range or comparison to fit their interest.

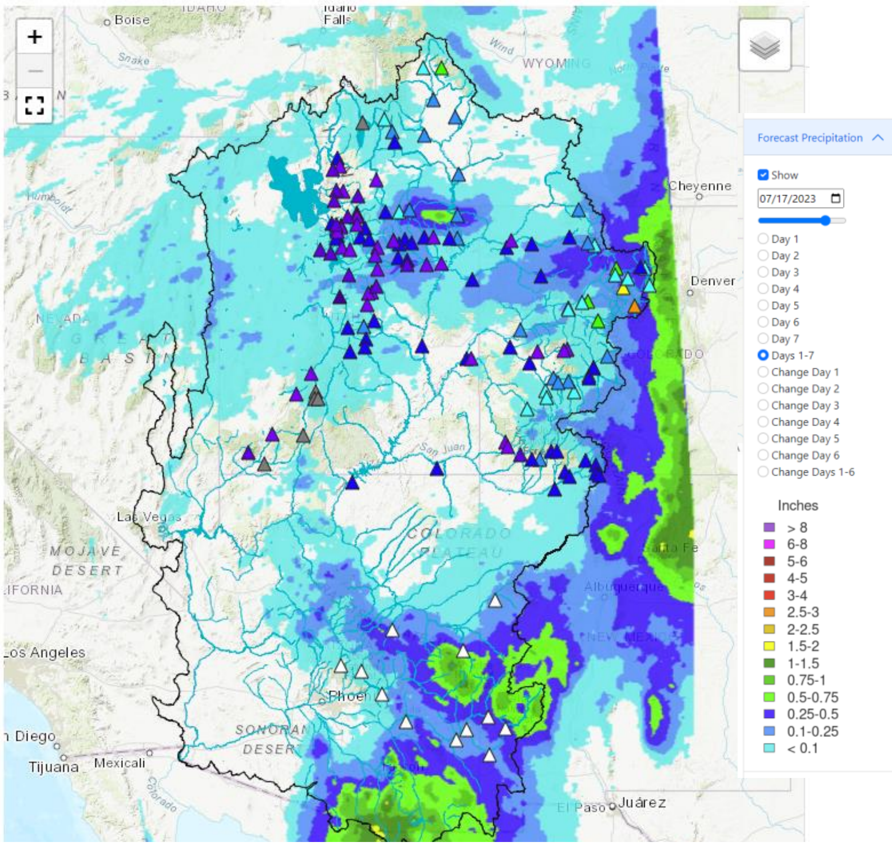


Figure 11: Users of the CBRFC website now have the ability to overlay gridded forecast precipitation values on the CBRFC's interactive map located on the CBRFC's homepage.

3.8 Updated Stick Diagrams

The CBRFC recently updated the model "stick" diagrams to reflect the latest model configuration, and to add some increased functionality to the diagrams. These stick diagrams illustrate how flows are routed through the CBRFC's hydrologic model and include the placement of reservoirs, diversions, exports, and imports. Additionally, the stick diagrams show where unmeasured depletions and return flows are accounted for, and the average annual values associated with those unmeasured values. The updated stick diagrams allow the user to click on a particular segment and link to the CBRFC's short-term hydrograph. CBRFC stick diagrams can be found here[8] (Figure 12).

[8] For those unable to use the hyperlink: https://www.cbrfc.noaa.gov/wsup/guide/sticks.html

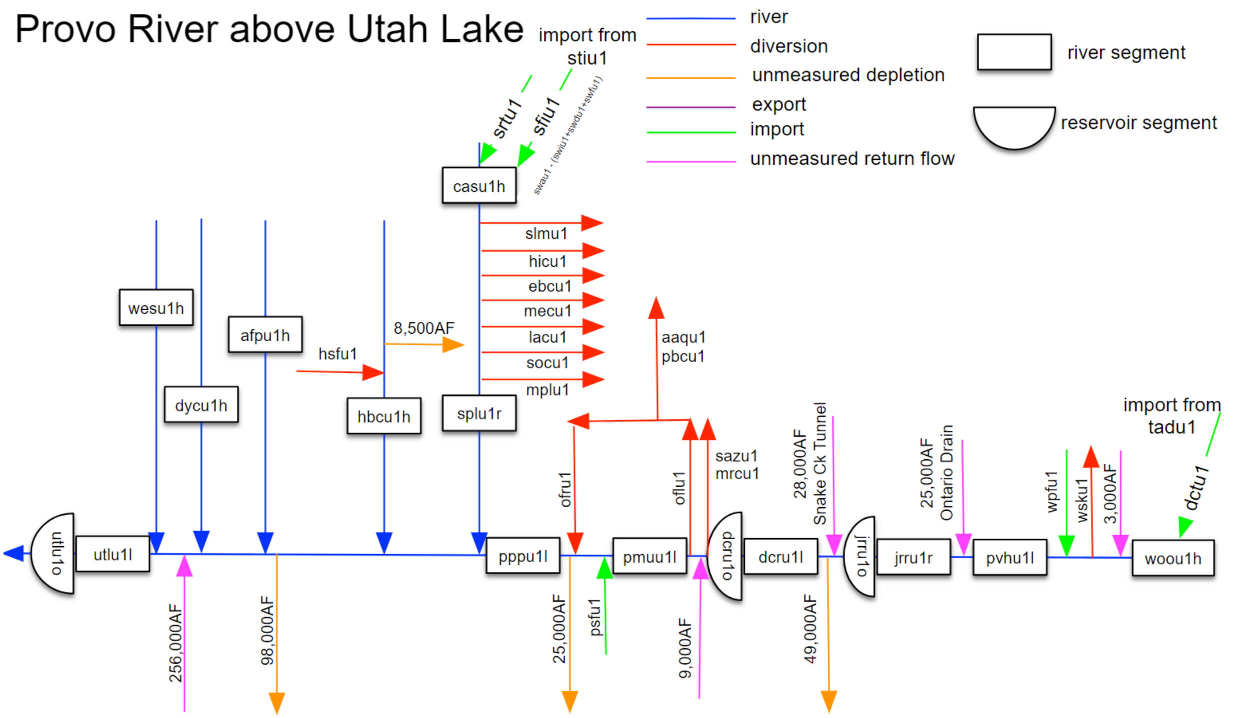


Figure 12: The CBRFC recently updated its stick diagrams. The figure above shows how streamflow is routed between forecast points over the Provo River Basin.

3.9 Updated Soil Moisture Maps

The CBRFC updated its gridded fall soil moisture maps, which are available here[9]. Before this update, the "significant area" mask applied to the soil moisture maps was inconsistent with the significant areas defined for other model parameters. After the update, the significant areas associated with all parameters and maps on the CBRFC website were identical. "Significant area" on these maps highlights those areas that contribute in an impactful way to streamflow in the area.

3.10 Increased Social Media Presence

The CBRFC has long held an account on Facebook and Twitter, as nearly all offices within the NWS do; however, the activity level of the CBRFC on these social media channels was not comparable to some of the CBRFC's more active colleagues at WFOs and some other RFCs. The CBRFC began to increase its presence on social media by routinely posting updates, increasing the amount of followers on both social media platforms. The CBRFC can be found on Twitter and Facebook using the handle @nwscbrfc.

[9] For those unable to use the hyperlink: https://www.cbrfc.noaa.gov/rmap/grid800/index_soil.php

4 Research, Investigations, and Collaborations

4.1 Continued Investigation of the Use of Remotely Sensed Snow Data

The CBRFC continues to actively investigate the use of remotely sensed snow data for operational use. In 2021, the CBRFC developed processes to directly insert remotely sensed snow information primarily developed by Airborne Snow Observatory Inc. (ASO) and the Colorado Airborne Snow Measurement (CASM) groups. This process was further developed to include the development of an experimental forecast product summary that is distributed to interested stakeholders comparing forecasts developed using the traditional CBRFC forecasting paradigm, and forecasts developed using remotely sensed snowpack information. Due to the limited amount of remotely sensed snowpack information, it is difficult to quantify the impact of remotely sensed snowpack information to forecast skill, but the information derived here will eventually form a basis from which to make informed decisions on the applicability of remotely sensed snow information to operational forecasts. Figure 13 shows an example of the experimental forecast product provided to stakeholders.

4.2 Investigation of iSNOBAL Model

The CBRFC currently simulates snowpack accumulation and ablation through the use of the SNOW-17[10] model. SNOW-17 is a temperature index model that utilizes precipitation, temperature, and freezing level to model snowpack accumulation and melt. While computationally efficient and accurate, a spatially distributed, physically based snow model may aid in the improvement of forecast skill, particularly as the CBRFC investigates the use of distributed hydrologic models. The CBRFC is working with the University of Utah to investigate the potential benefit of utilizing the iSNOBAL mass and energy balance model. The model has been set up on an experimental basis over the East River at Almont, CO (ALEC2) and the Blue River above Dillon, CO (DIRC2) forecast points. An operational framework for running the distributed snow model is under active development. Currently, the distributed model run is automated, which includes downloading and distributing weather forcing information from the High-Resolution Rapid Refresh (HRRR) model over the domain, and running the distributed model through 23Z. Diagnostic tools have been built to compare mean areal iSNOBAL SWE to operational SNOW-17 elevation zone SWE, and SNOTEL SWE to adjacent iSNOBAL pixel SWE (Figure 14).

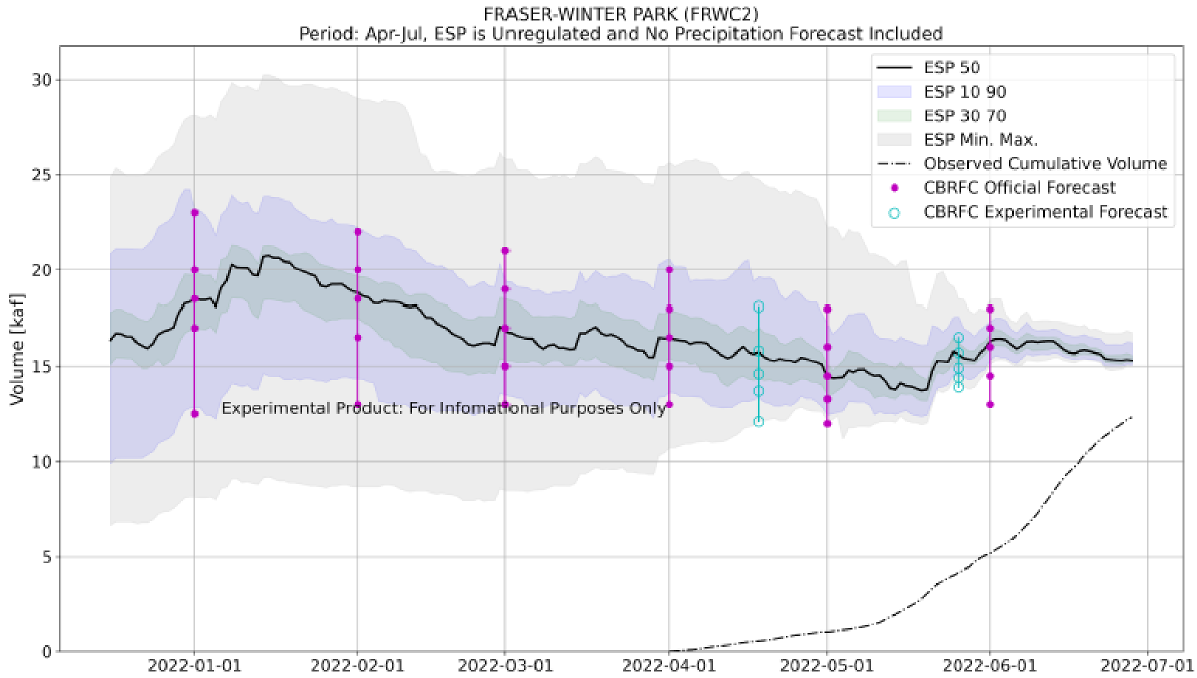
[10] See "Snow Accumulation and Ablation Model – Snow -17", 2006, by Eric Anderson. Available at: https://www.weather.gov/media/owp/oh/hrl/docs/22snow17.pdf

Experimental Seasonal (Apr - Jul) CBRFC Forecast with direct insertion of estimated SWE from airborne lidar survey

Location: Fraser - Winter Park (FRWC2)

Date of Flight: May 26, 2022

This experimental forecast product is provided for information purposes only and is not intended as an official forecast product of the Colorado Basin River Forecast Center (CBRFC). The experimental forecast shown in blue on the figure and provided in the table is created by running the Ensemble Streamflow Prediction (ESP) model after direct insertion of basin average snow water equivalent (SWE) from Airborne Snow Observatory Inc. (ASO) into the CBRFC's operational, calibrated, and lumped parameter snow model (SNOW-17). Please contact the CBRFC with any questions regarding these numbers or figures.



Forecast / Exceedance Value	ESP90	ESP70	ESP50	ESP30	ESP10
CBRFC Experimental Forecast 5/26/2022	13.9	14.4	14.9	15.7	16.5
CBRFC ESP Model Guidance 5/26/2022	14.5	15.1	15.6	16.2	17.6

Probabilistic forecast volumes in thousands of acre-feet (kaf). Columns indicate exceedance values.

Contact: cbrfc.operations@noaa.gov - https://www.cbrfc.noaa.gov/us/us.php

Figure 13: The CBRFC distributes an experimental forecast product illustrating the impact of using remotely sensed snowpack information to water supply forecasts in applicable areas.

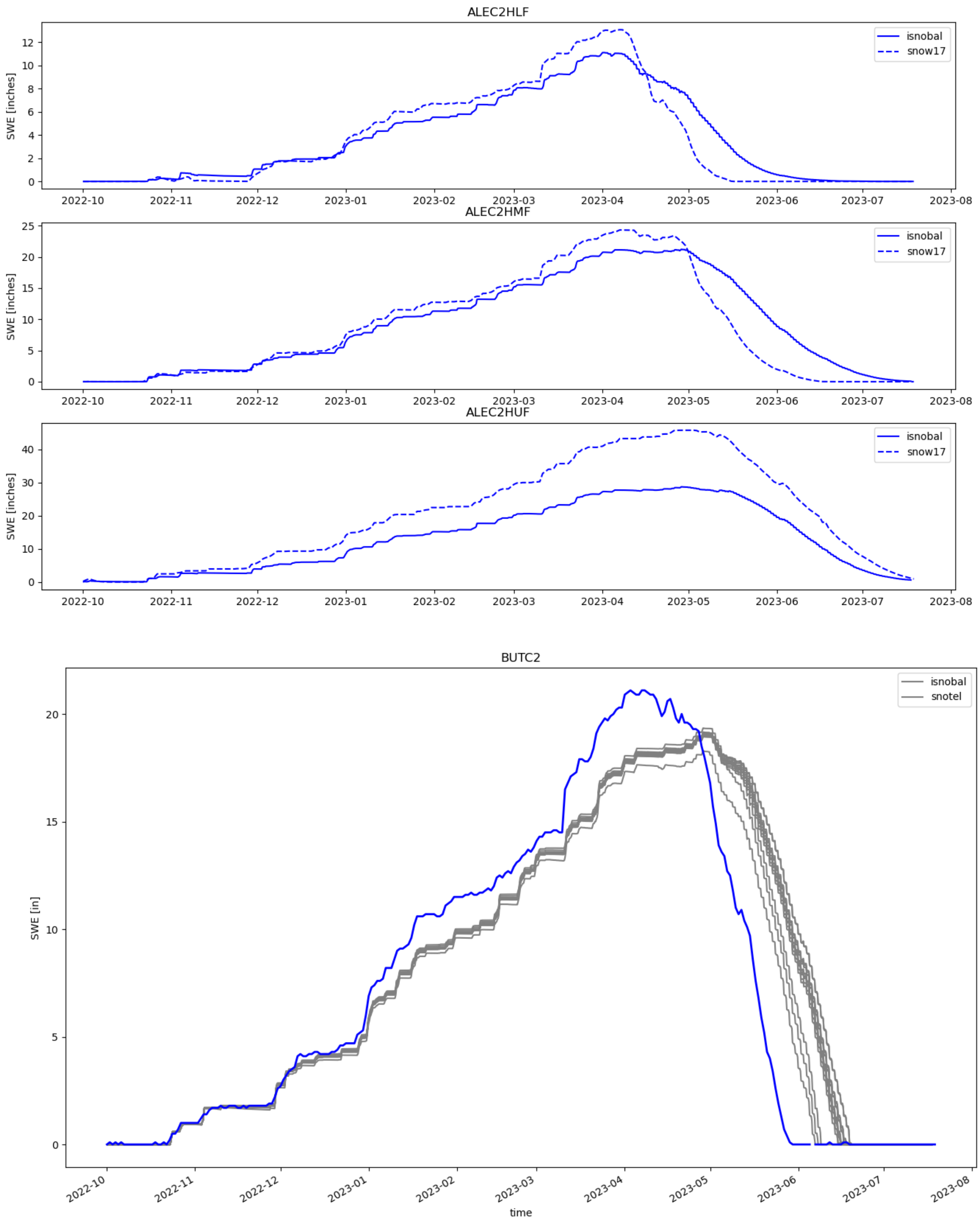


Figure 14: iSNOBAL SWE values are compared to model SWE values at different elevation zones at ALEC2 (top). SNOTEL SWE is compared to iSNOBAL model SWE at adjacent pixels (bottom).