

Colorado River Basin Water Supply Briefing

February 5, 2021

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Colorado Basin River Forecast Center

Please mute your phone until the question period



Today's Presentation

Precipitation Review

Soil Moisture Conditions

Current Snowpack

2021 Water Supply Forecasts

**Webinar recording & slides will be
made available on CBRFC webpage**

Upcoming Weather

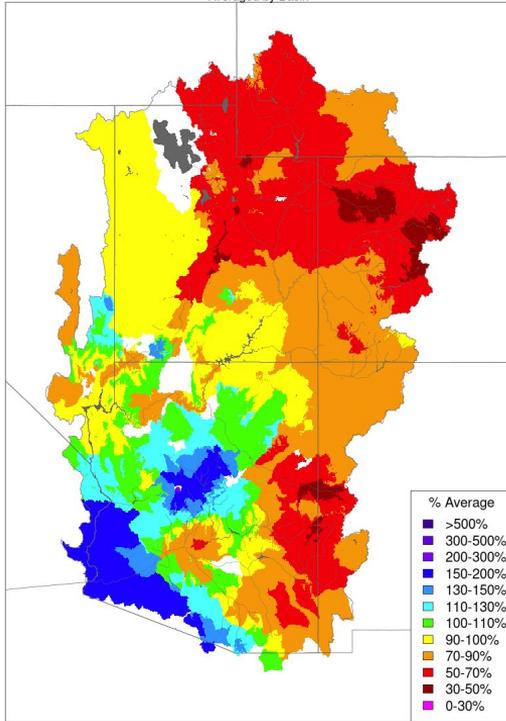
February Forecast Error

CBRFC Hydro Science Update

Contacts & Questions

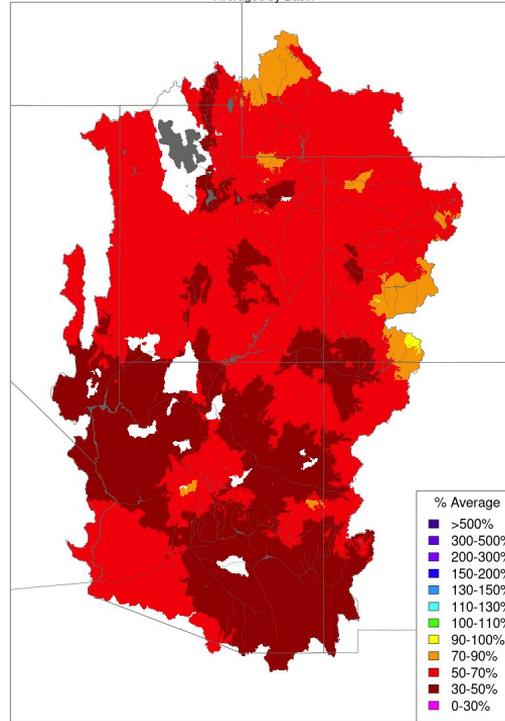
Precipitation Summary

Monthly Precipitation - January 2021
Averaged by Basin



Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

Water Year Precipitation, October 2020 - January 2021
Averaged by Basin



Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbrfc.noaa.gov

Water Year 2021 Oct-Jan Precip Summary

<u>Basin</u>	<u>Precip (% Avg)</u>
Upper Green	75%
Duchesne	60%
Price/San Rafael	55%
Yampa/White	60%
Upper CO Mainstem	65%
Gunnison	70%
Dolores	65%
San Juan	75%
Lake Powell	65%
Virgin	60%
Verde	55%
Salt	50%
Little Colorado	55%
Upper Gila	45%

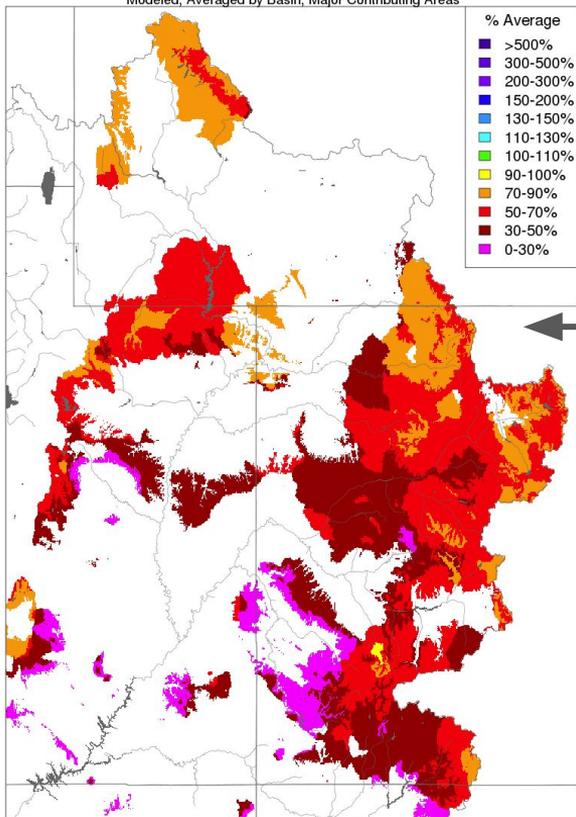
Southern (Lower Colorado/Arizona) basins benefited the most from late January weather pattern shift.

Soil Moisture Conditions

Upper Colorado River Basin

Soil Moisture - Fall - 2020 (November 15)

Modeled, Averaged by Basin, Major Contributing Areas



Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbRFC.noaa.gov

Water supply impacts are most pronounced when soil moisture conditions and snowpack conditions are both much above or much below average.

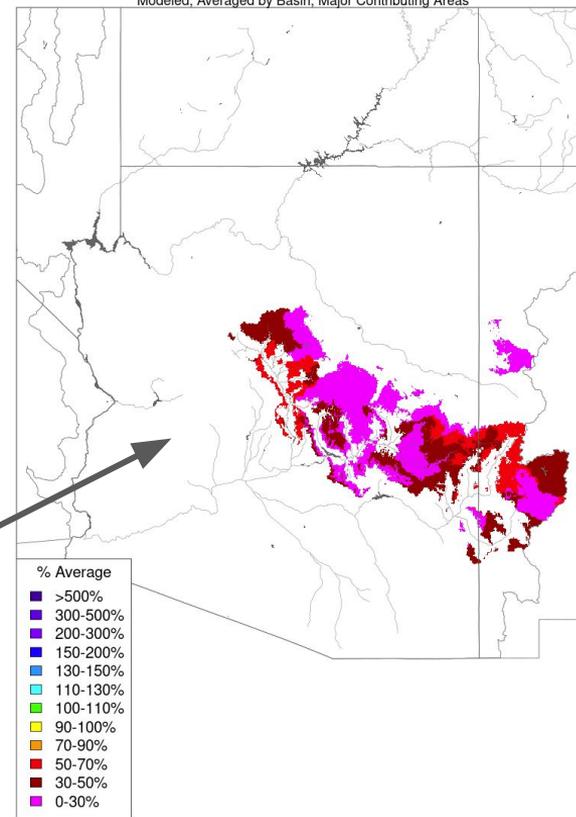
Model soil moisture is generally in the bottom 5 across the Upper Colorado over the 1981-2020 40-year period. The San Juan and Dolores are generally in the bottom 3 with some areas being record dry.

Although winter soil moisture conditions have improved since early January in parts of the Verde and Salt River Basins due to recent precipitation, soil moisture conditions in the Lower Colorado River Basin still remain below to much below average.

Lower Colorado River Basin

Soil Moisture - February 03 2021

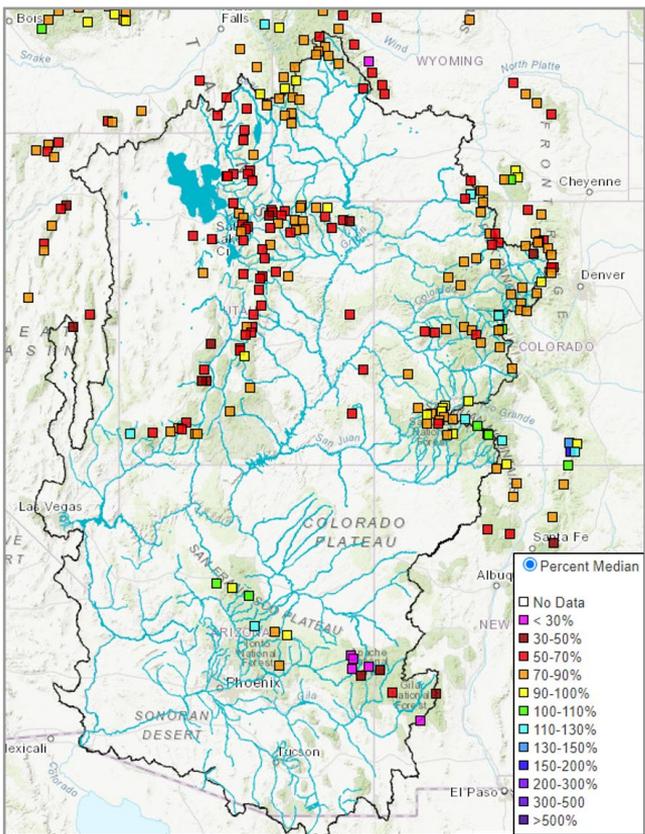
Modeled, Averaged by Basin, Major Contributing Areas



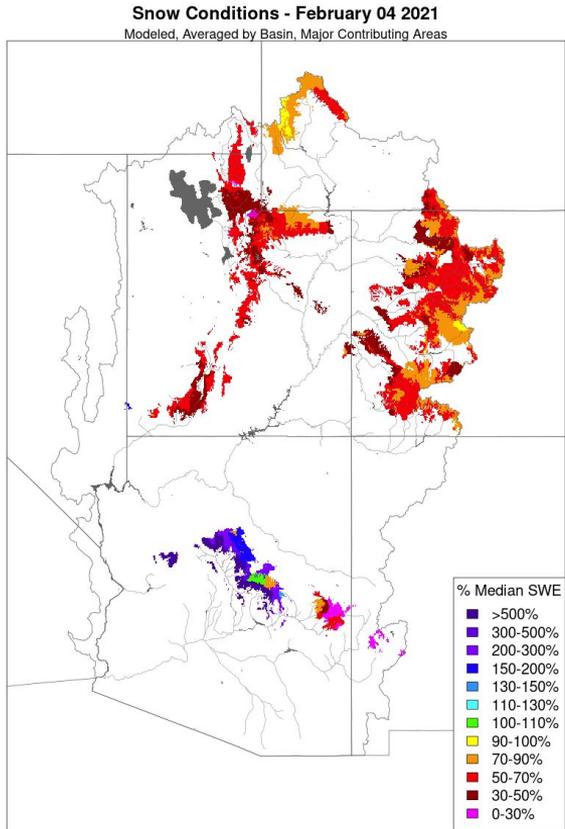
Prepared by NOAA, Colorado Basin River Forecast Center
Salt Lake City, Utah, www.cbRFC.noaa.gov

Early February Snow Conditions

SNOTEL (Observed)



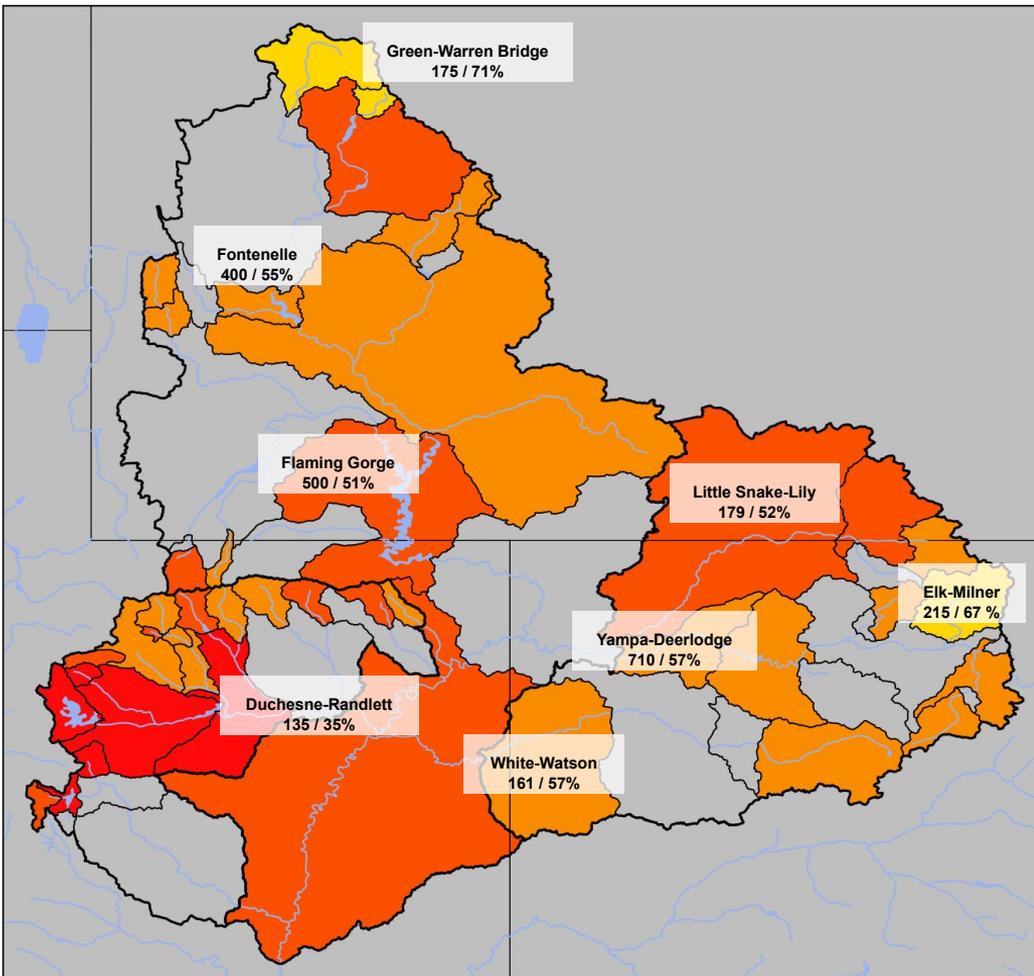
CBRFC (Model)



Feb 4 SWE Summary (SNOTEL)

Basin	SWE (% Median)
Upper Green	80%
Duchesne	65%
Price/San Rafael	60%
Yampa/White	75%
Upper CO Mainstem	75%
Gunnison	75%
Dolores	80%
San Juan	90%
Lake Powell	75%
Virgin	70%
Verde	100%
Salt	25%
Little Colorado	55%
Upper Gila	40%

Feb 1st Water Supply Forecasts: Green, Yampa, White, Duchesne



February 1st 2021 Forecasts

Volume (kaf) / % of 1981-2010 avg

Forecast Ranges & (1-month Trend)

Upper Green: 50 - 70% avg
(5-10% decrease)

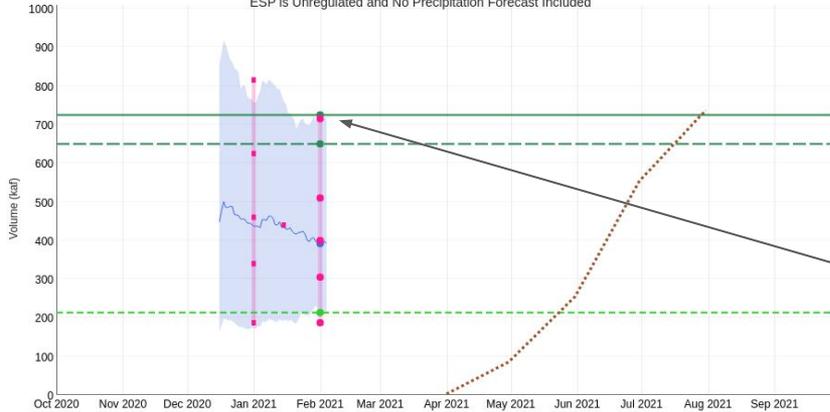
Yampa/White: 50 - 65% avg
(10-15% decrease)

Duchesne: 35 - 60% avg
(0-5% decrease)

Upper Green Water Supply Forecasts & Snow Conditions

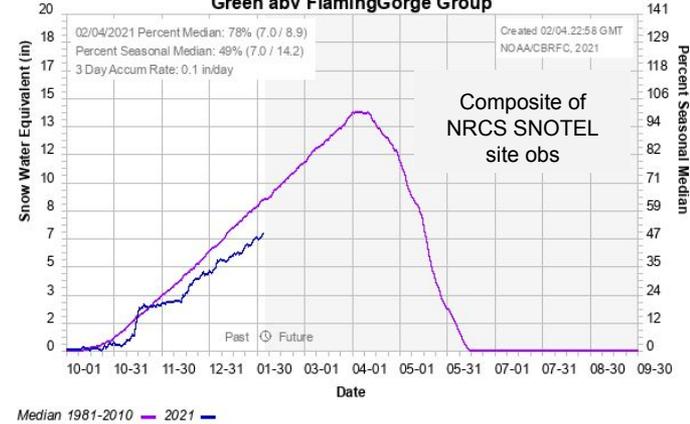
Green - Fontenelle Reservoir, Fontenelle, Nr (GBRW4)
 Period: Apr-Jul, Official 50% Forecast (2021-02-01): 400 kaf (55% Average, 62% Median)
 ESP is Unregulated and No Precipitation Forecast Included

2021/02/01:
 Min 1977: 213.31
 Average: 725
 Median: 650
 ESP: 392
 Official 10: 715
 Official 30: 510
 Official 50: 400
 Official 70: 305
 Official 90: 187



Based on current conditions there is a 10% chance for above average volumes and a 10% or greater chance for record low water supply volumes in the Green River Basin.

Colorado Basin River Forecast Center
 Green abv FlamingGorge Group



Green - Flaming Gorge Reservoir (GRNU1)
 Period: Apr-Jul, Official 50% Forecast (2021-02-01): 500 kaf (51% Average, 60% Median)
 ESP is Unregulated and No Precipitation Forecast Included

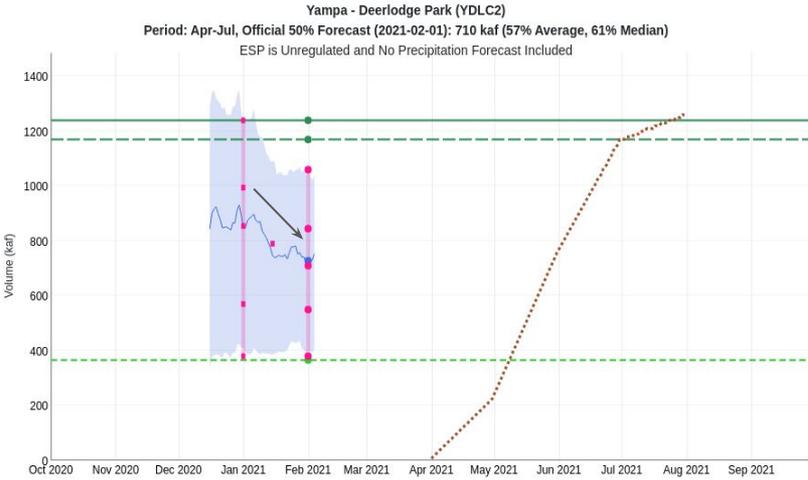
2021/02/01:
 Min 1977: 254.3
 Average: 980
 Median: 830
 ESP: 466
 Official 10: 990
 Official 30: 660
 Official 50: 500
 Official 70: 385
 Official 90: 265



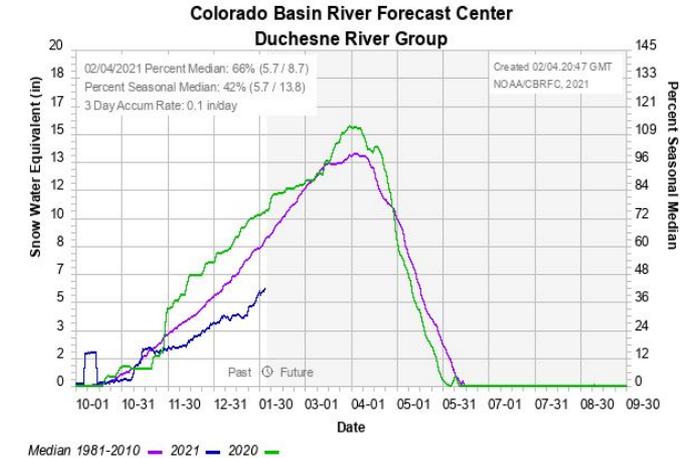
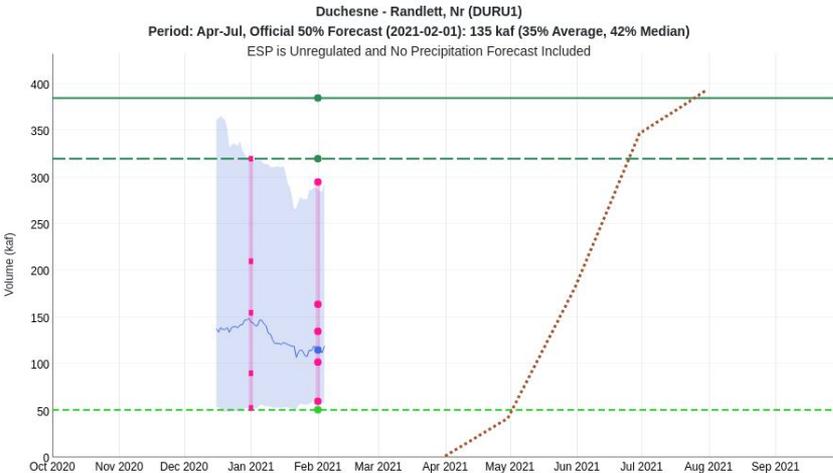
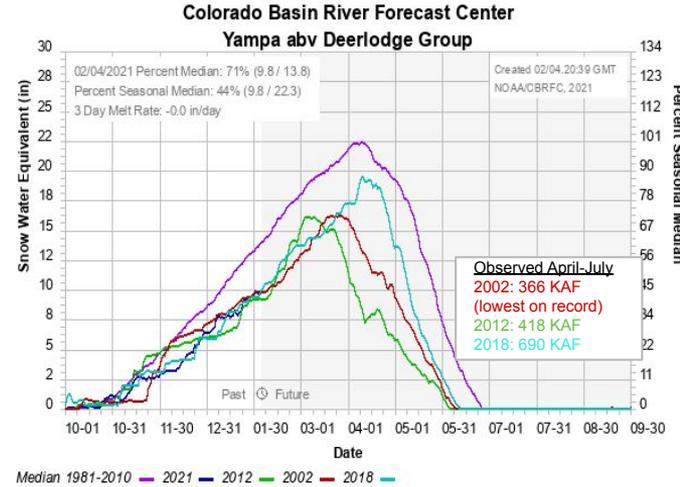
Flaming Gorge Reservoir Inflow Current analog SWE years:

Year	SWE	APR-JULY	% AVG
2001	7.0"	439 kaf	45%
1992	7.3"	348 kaf	36%
1988	7.6"	566 kaf	58%

Yampa & Duchesne Water Supply Forecasts & Snow Conditions



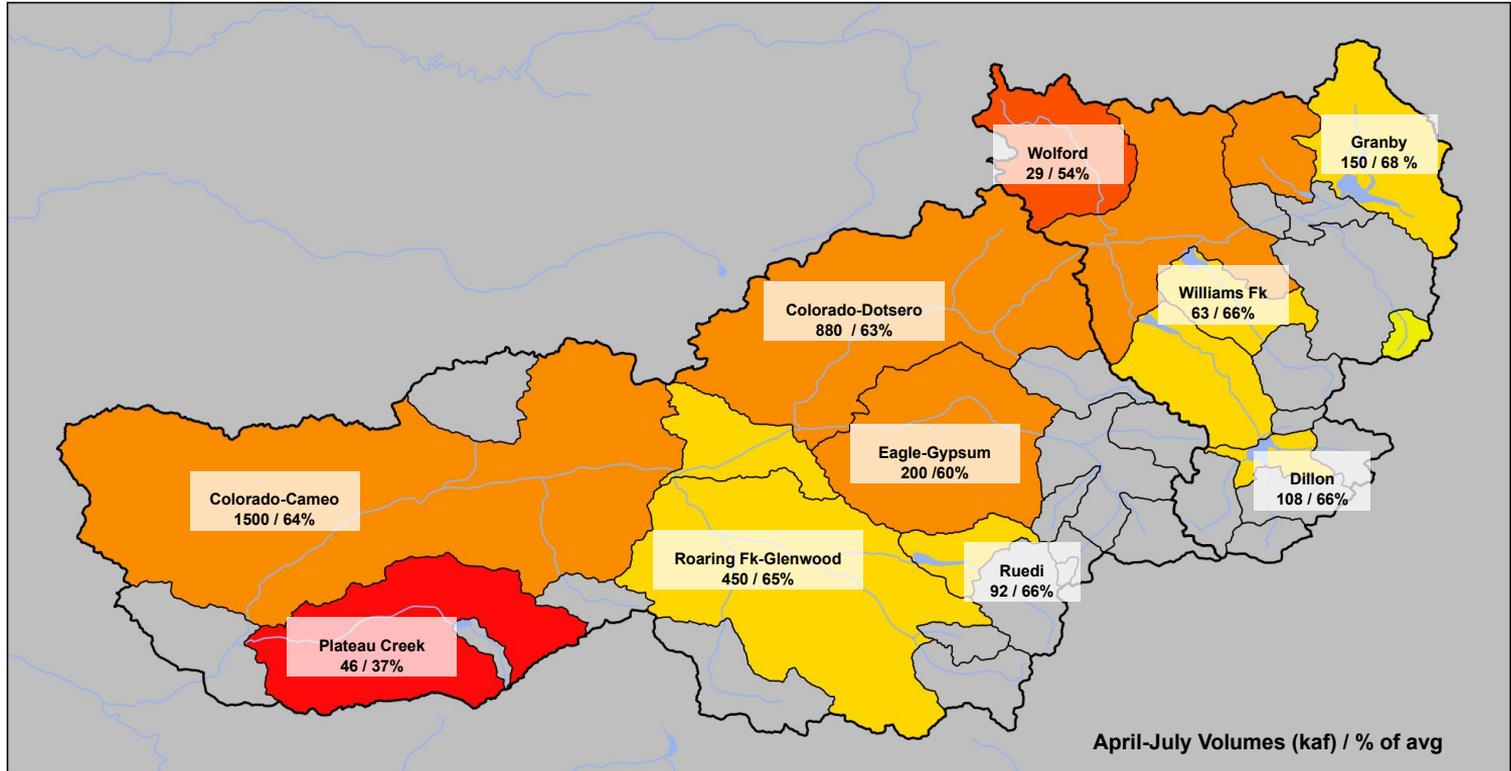
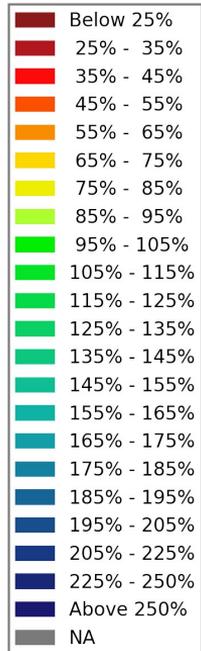
Forecasts in the Yampa River have decreased from early January as a result of below average precipitation in January.



Feb 1st Water Supply Forecasts: Upper Colorado River Mainstem

Forecast Ranges & (1-month Trend):

Granby to Kremmling: 55 - 75% avg (0-10% decrease)
Kremmling to Cameo: 35 - 65% avg (0- 5% decrease)

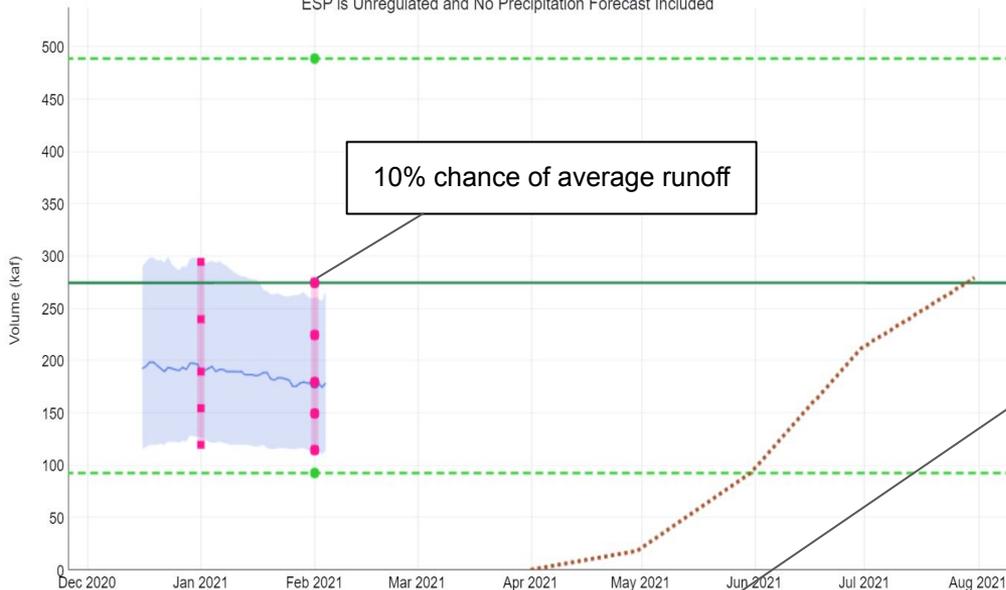


Upper Colorado Mainstem Water Supply Forecasts & Snow Conditions

Blue - Green Mtn Reservoir (GMRC2)

Period: Apr-Jul, Official 50% Forecast (2021-02-01): 180 kaf (65% Average, 69% Median)

ESP is Unregulated and No Precipitation Forecast Included



2021/02/01:

Max 1984: 489.26

Min 2002: 93.07

Average: 275

ESP: 179

Official 10: 275

Official 30: 225

Official 50: 180

Official 70: 150

Official 90: 115

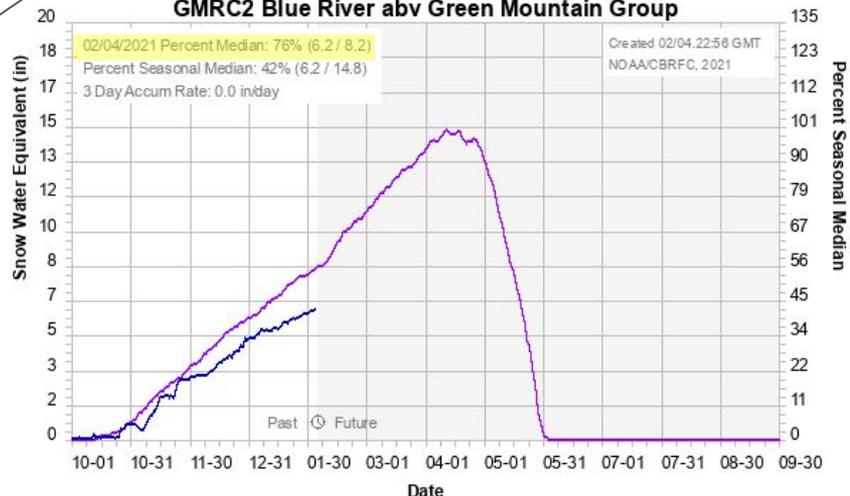
Current Analog SWE Year Analysis:

Year	SWE	AMJJ OBS	Feb 4 ESP
2002	6.0"	93 kaf	90 kaf
2010	6.5	239	180
1983	6.6	385	295

2002: near norm soils, below norm spring precip
 2010: near norm soils, near norm spring precip
 1983: above norm soils, wet/cold spring, late melt

2021: much below norm soils, feb-jul weather?

Colorado Basin River Forecast Center
 GMRC2 Blue River abv Green Mountain Group

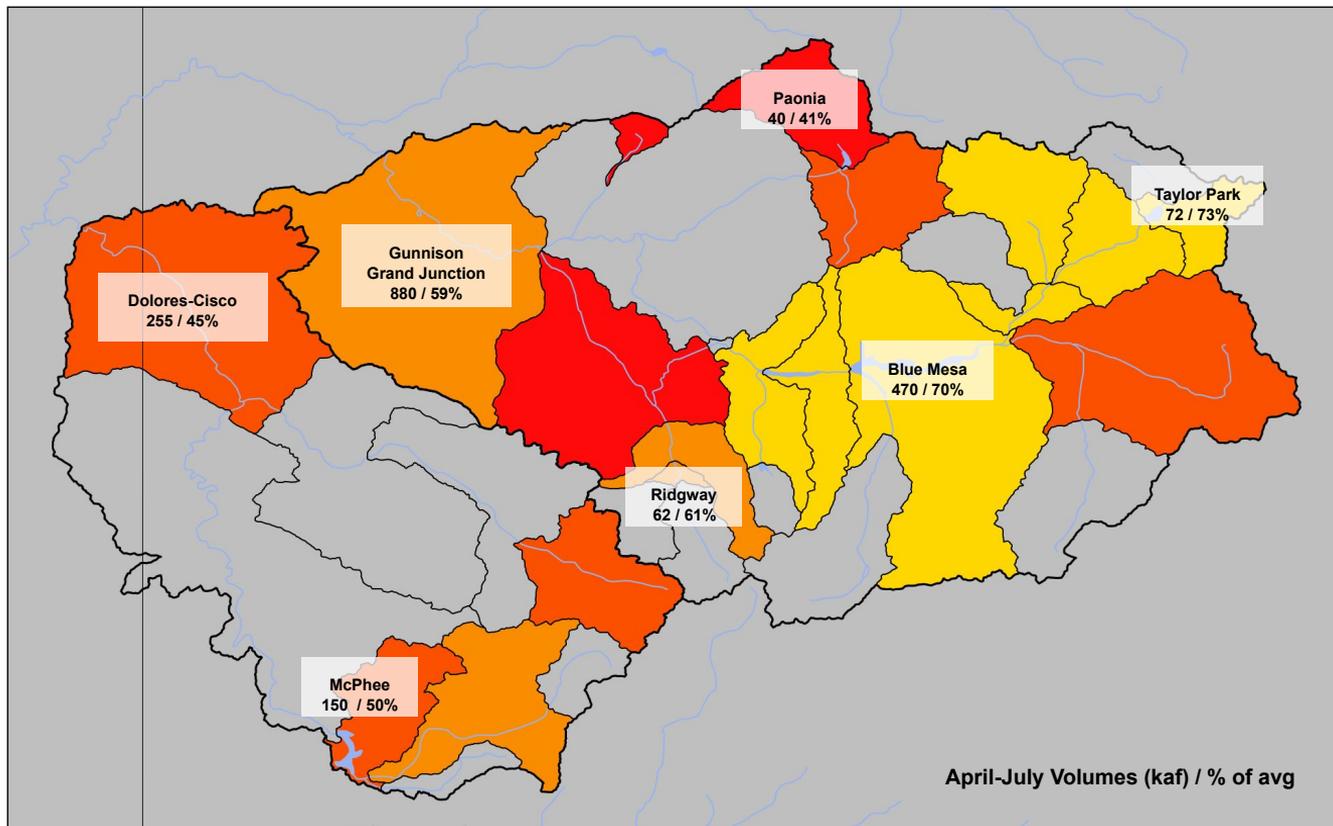
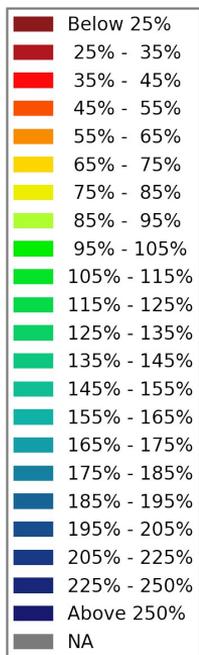


Feb 1st Water Supply Forecasts: Gunnison, Dolores

Forecast Ranges & (1-month Trend):

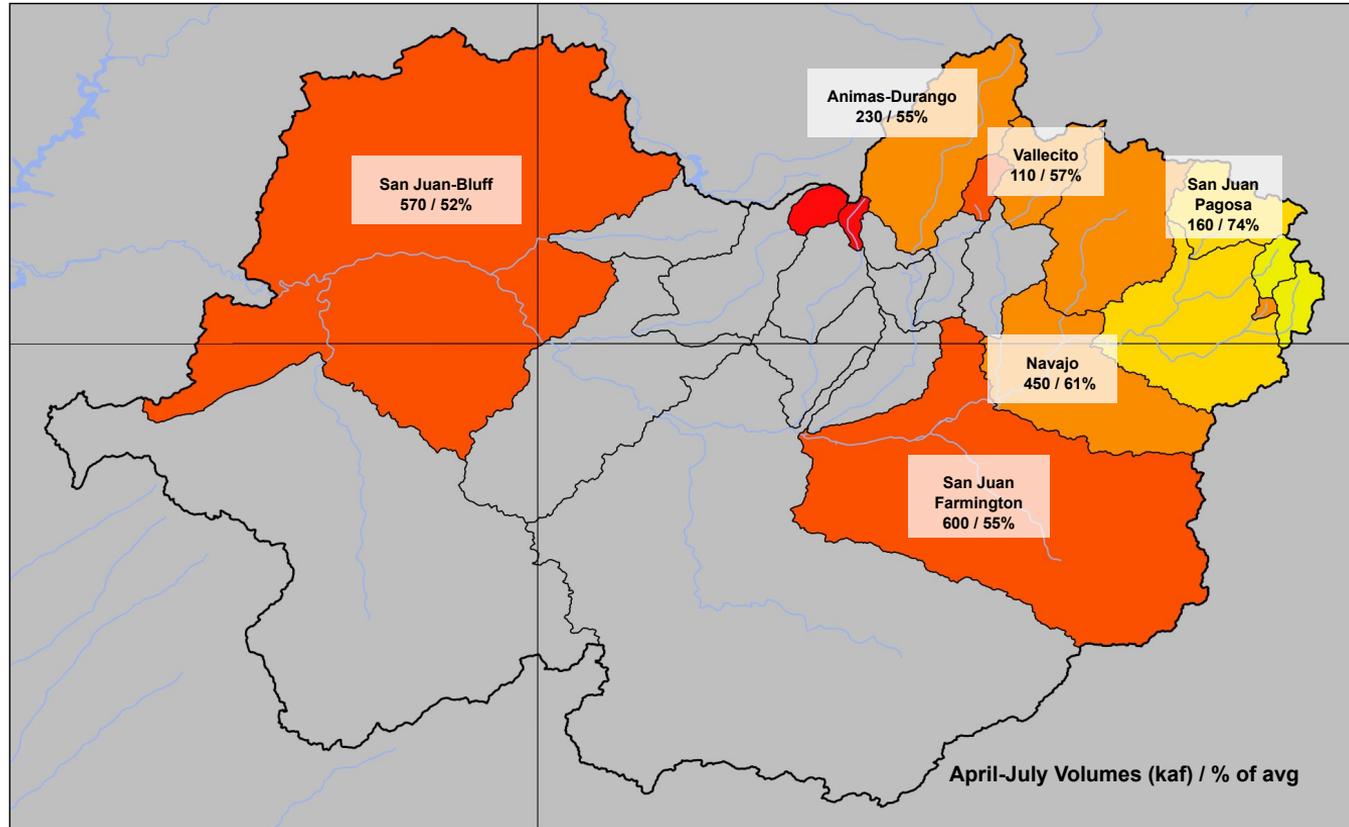
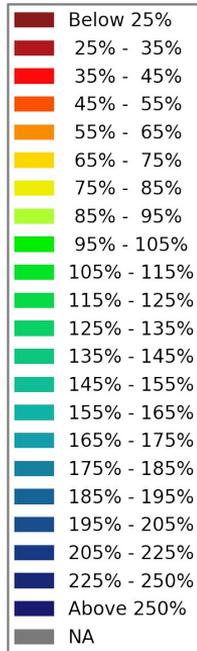
Gunnison: 40 - 75% avg (0- 5% decrease)

Dolores: 45 - 55% avg (5-10% decrease)



Feb 1st Water Supply Forecasts: San Juan

Forecast Range & (1-month Trend):
40 - 80% of average (0-5% decrease)



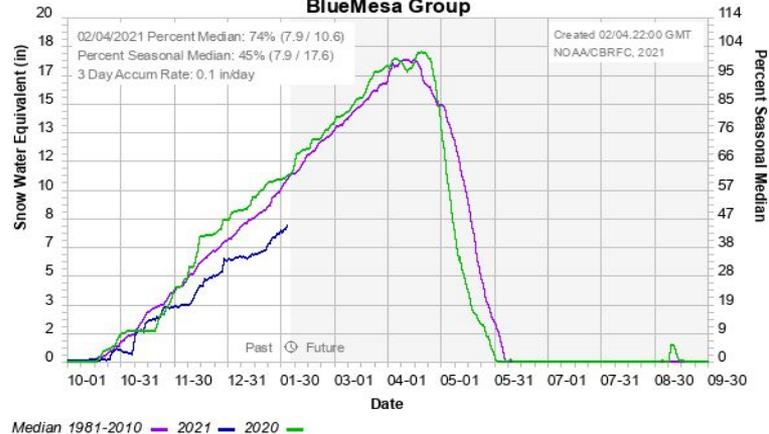
Southwest Colorado Water Supply Forecasts & Snow Conditions

Gunnison - Blue Mesa Reservoir (BMDC2)
 Period: Apr-Jul, Official 50% Forecast (2021-02-01): 470 kaf (70% Average, 82% Median)
 ESP is Unregulated and No Precipitation Forecast Included

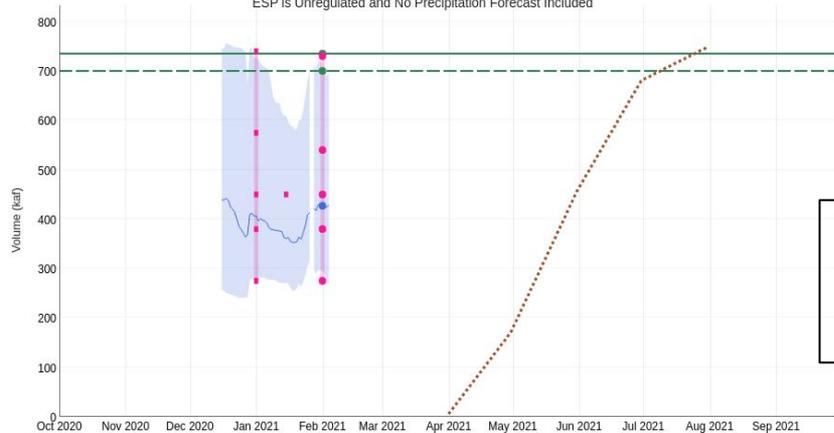


2021/02/01:
Average: 675
Median: 575
ESP: 464
Official 10: 710
Official 30: 590
Official 50: 470
Official 70: 395
Official 90: 320

Colorado Basin River Forecast Center
BlueMesa Group



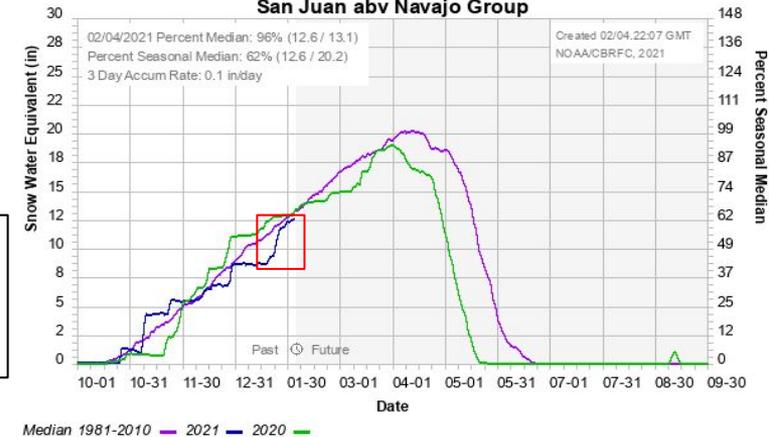
San Juan - Navajo Reservoir, Archuleta, Nr (NVRN5)
 Period: Apr-Jul, Official 50% Forecast (2021-02-01): 450 kaf (61% Average, 64% Median)
 ESP is Unregulated and No Precipitation Forecast Included



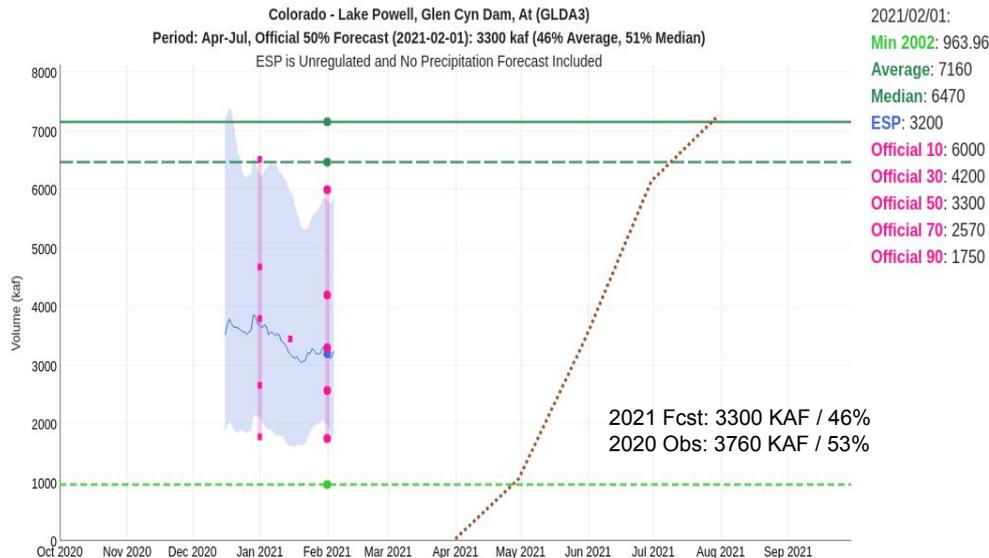
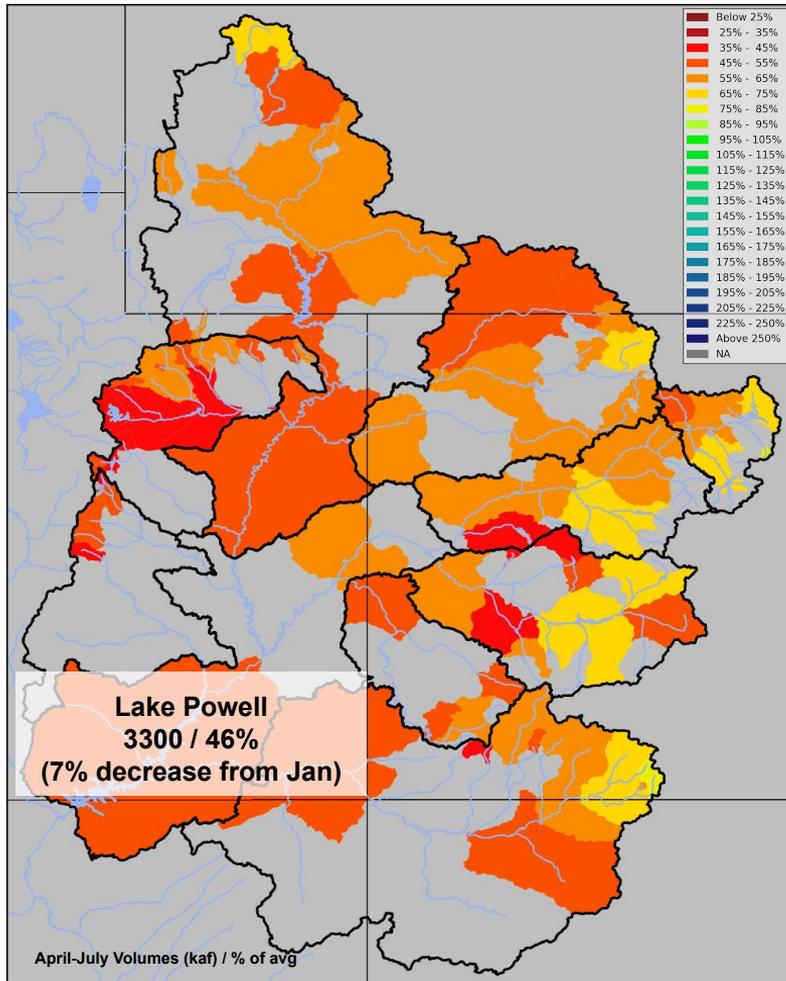
2021/02/01:
Average: 735
Median: 700
ESP: 427
Official 10: 730
Official 30: 540
Official 50: 450
Official 70: 380
Official 90: 275

The forecasts for the areas above Navajo Reservoir did not change due to storms the last half of the month.

Colorado Basin River Forecast Center
San Juan abv Navajo Group



Feb 1st Water Supply Forecasts: Upper Colorado (Lake Powell)



Lake Powell summarizes the hydrologic conditions throughout the Upper Colorado River Basin.

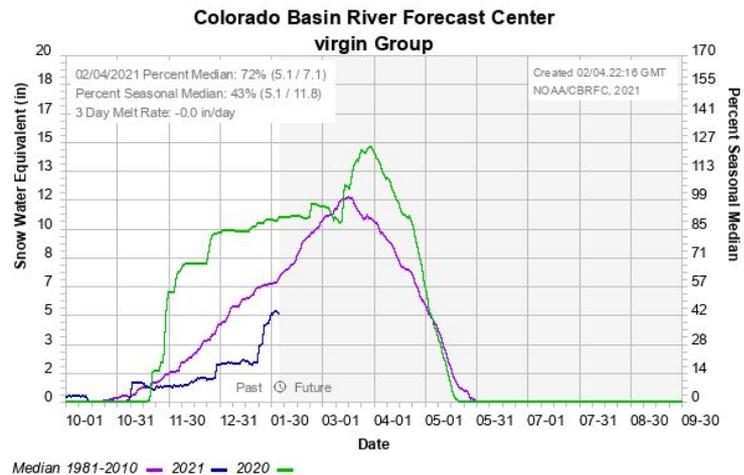
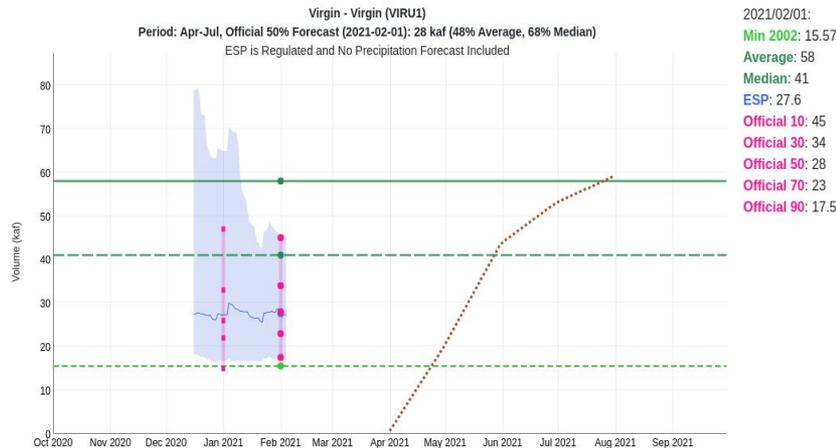
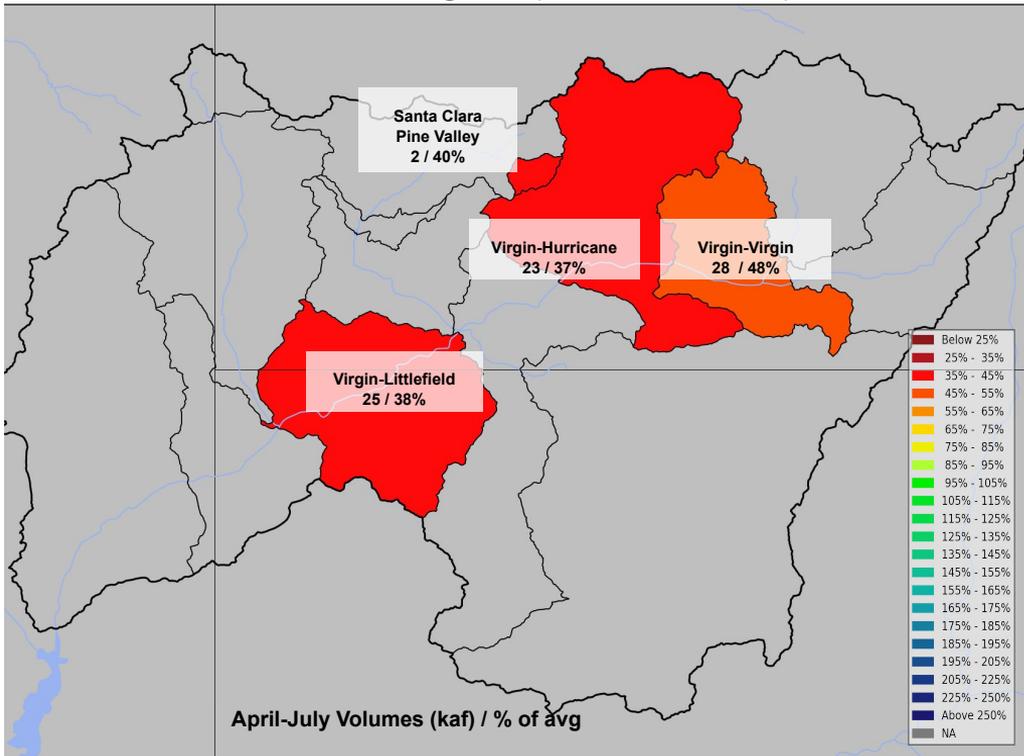
5 Lowest Historical Years: April-July Volume / % avg

2002:	946 KAF / 13%
1977:	1208 KAF / 17%
2012:	2063 KAF / 29%
2013:	2558 KAF / 36%
2018:	2602 KAF / 36%

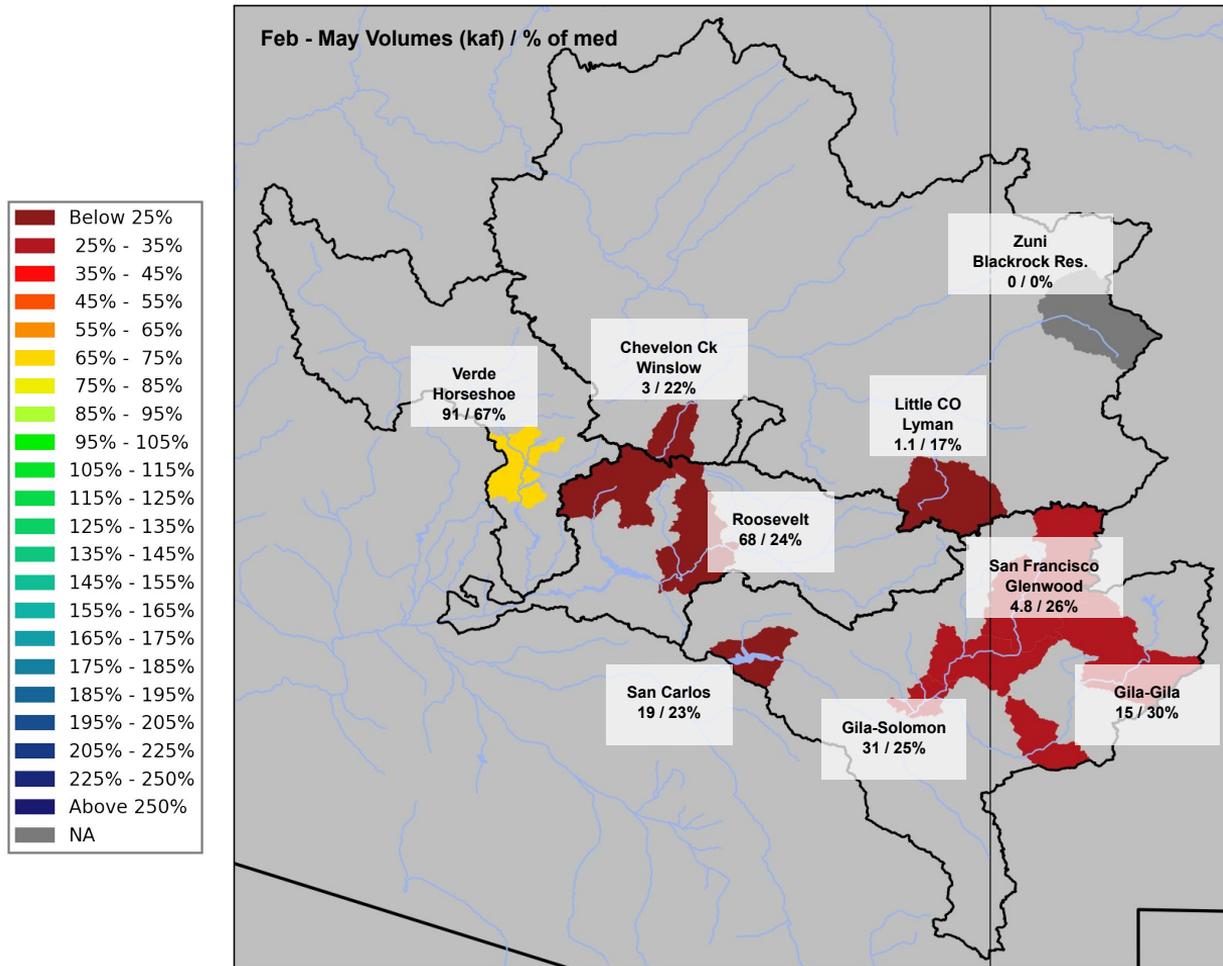
* Currently a ~30% chance to be in the bottom five

Feb 1st Water Supply Forecasts: Virgin River Basin

Forecast Range & (1-month Trend):
 35 - 45% avg (0-5% increase)



Feb 1st Water Supply Forecasts: Lower Colorado River Basin



February - May Forecast Period
Volume (kaf) / % of 1981-2010 Median

Forecast Ranges

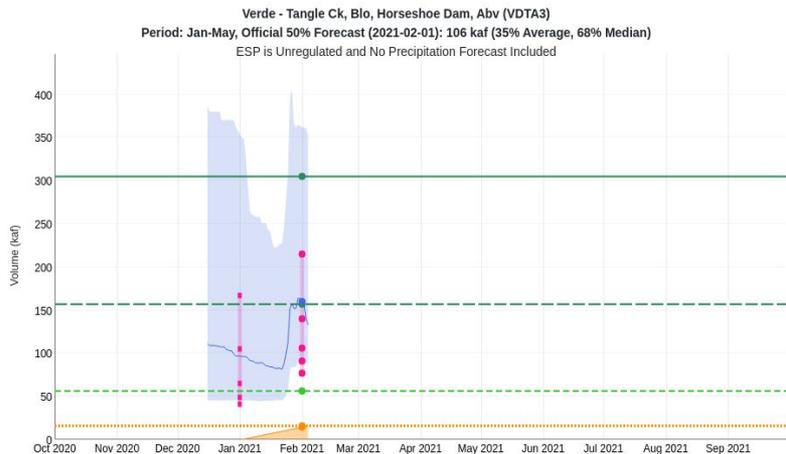
Little Colorado: 0 - 25%

Upper Gila: 20 - 30%

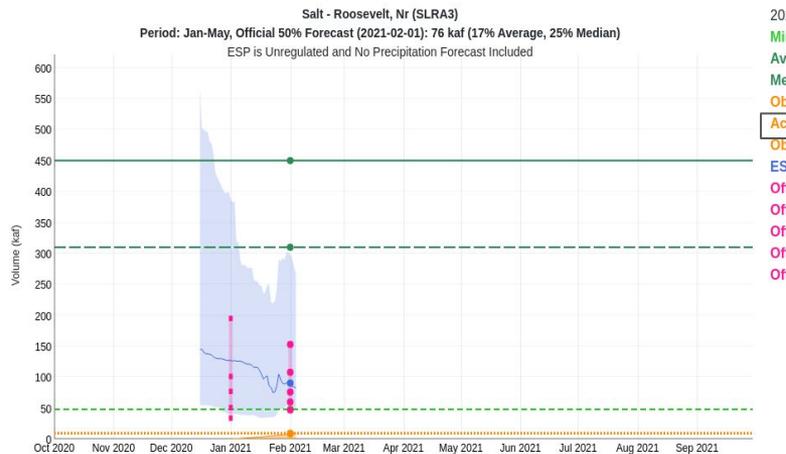
Salt: 20 - 25%

Verde: 65%

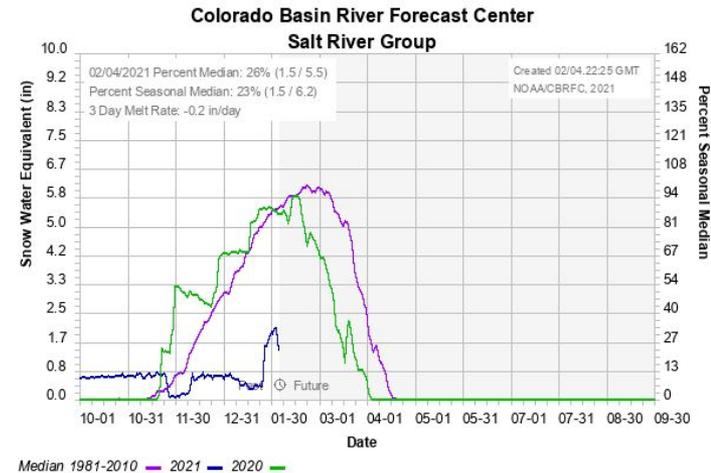
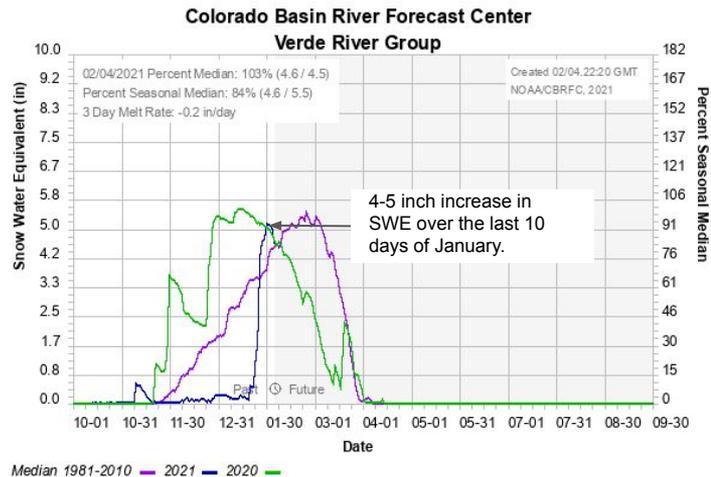
Lower Colorado Water Supply Forecasts & Snow Conditions



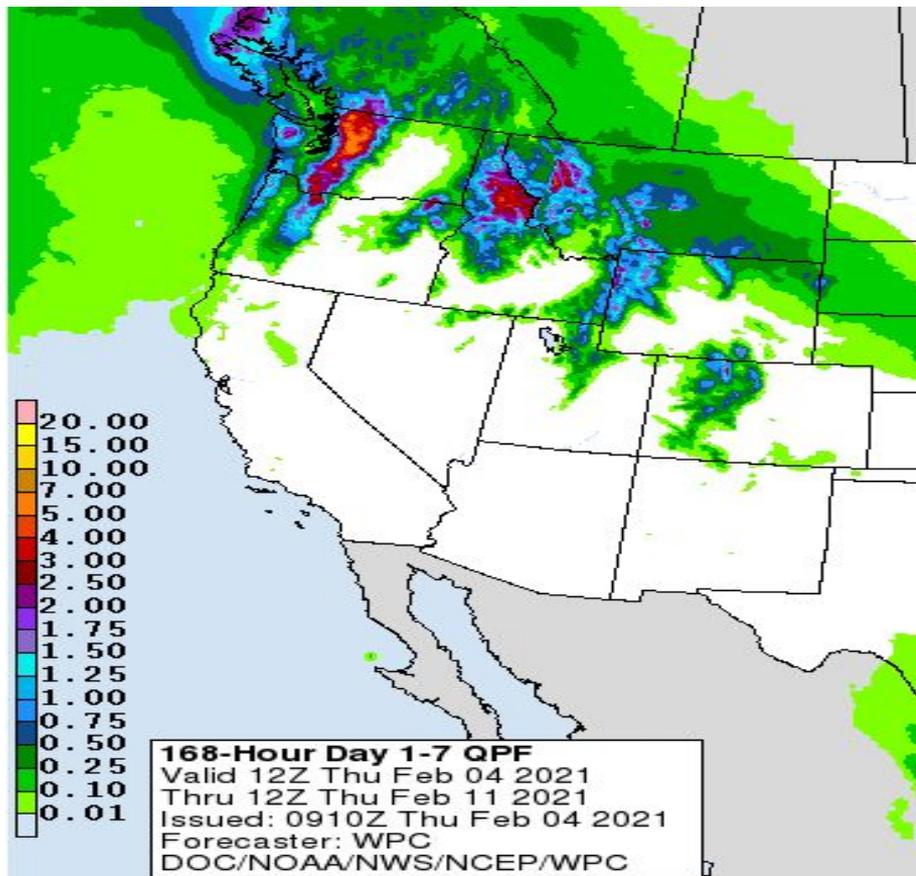
Forecasts in the Verde River basin increased as a result of precipitation over the second half of January.



Jan-May forecast period; start showing accumulated volume on Jan 1st.



Upcoming Weather: WPC February 4-11 Precipitation Outlook

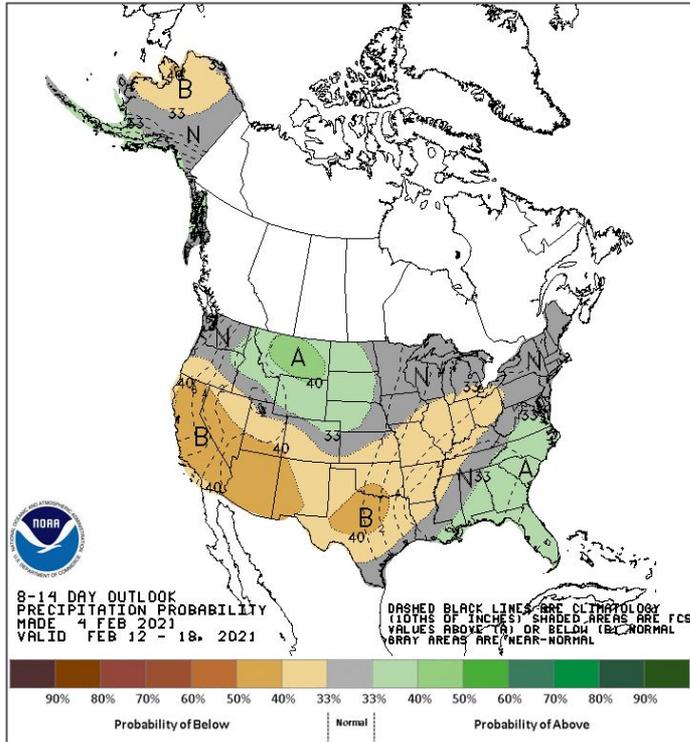


- Northwesterly flow to produce widespread 1-2 inches of precip through the weekend across the mountains of Wyoming and northern Utah/Colorado.
- Little to no precip forecasted across southern Utah and the Lower Basin.

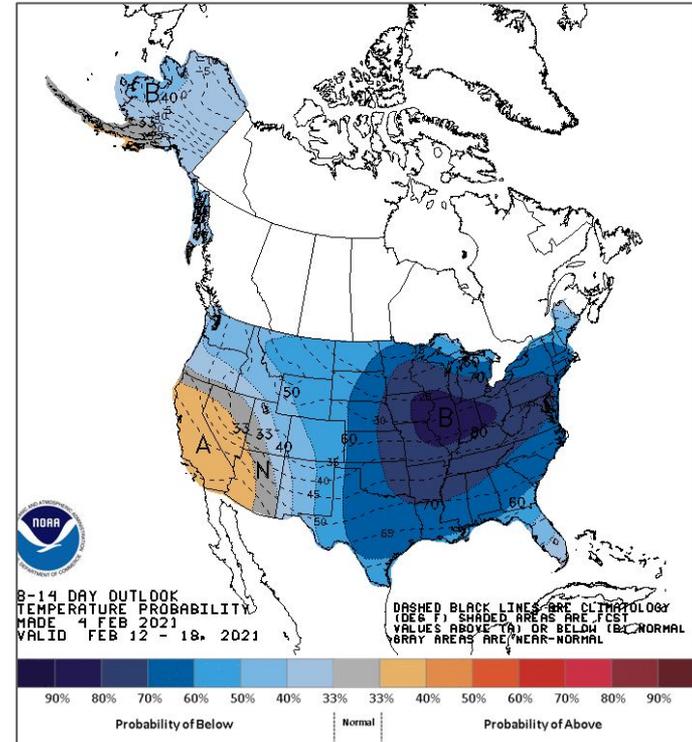
Upcoming Weather: 8-14 Day Outlook (February 12-18)

Slightly elevated odds of below (above) average precipitation across the south (north).
Temperatures mostly near to below normal.

Precipitation Outlook

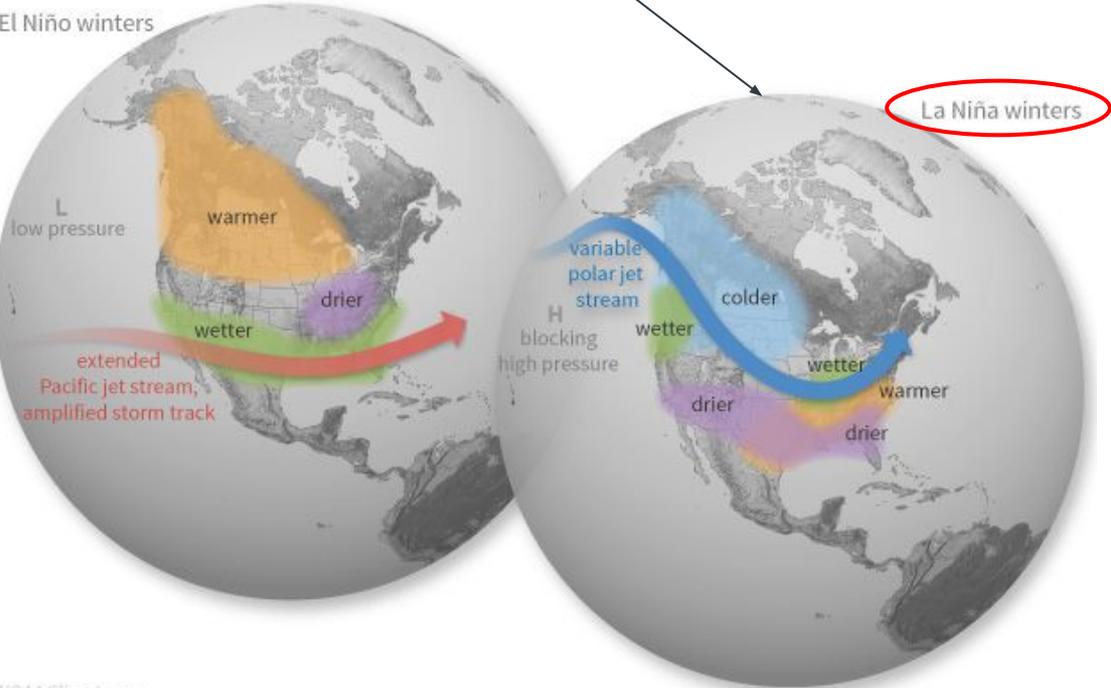


Temperature Outlook

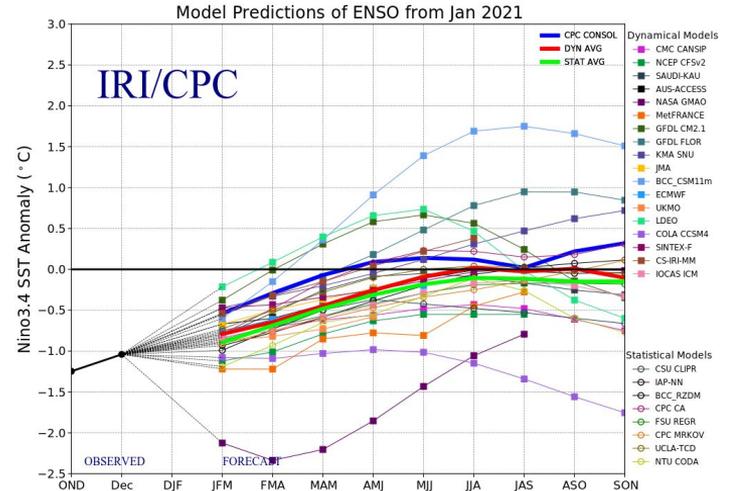
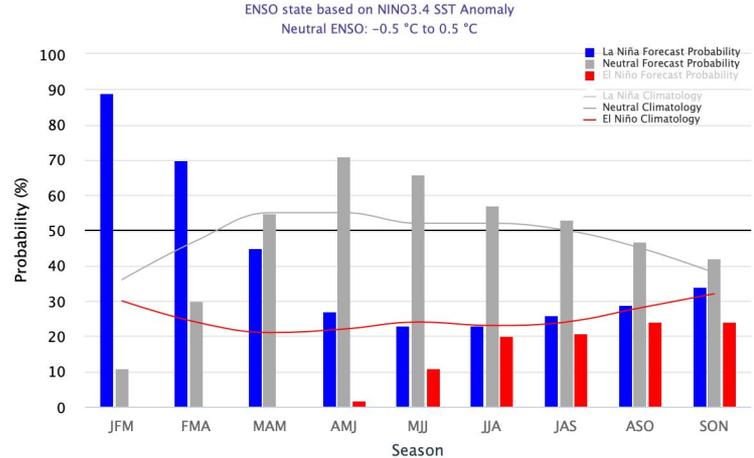


El Niño Southern Oscillation (ENSO) Status

- **La Niña** is expected to continue through the Northern Hemisphere winter 2020-21 (~95% chance during January-March), with a potential transition to ENSO-neutral during the spring 2021 (55% chance during April-June)
 - Increased chances of drier weather in Arizona/LCRB
 - Much weaker correlation/winter weather signal elsewhere in basin



Mid-January 2021 IRI/CPC Model-Based Probabilistic ENSO Forecasts

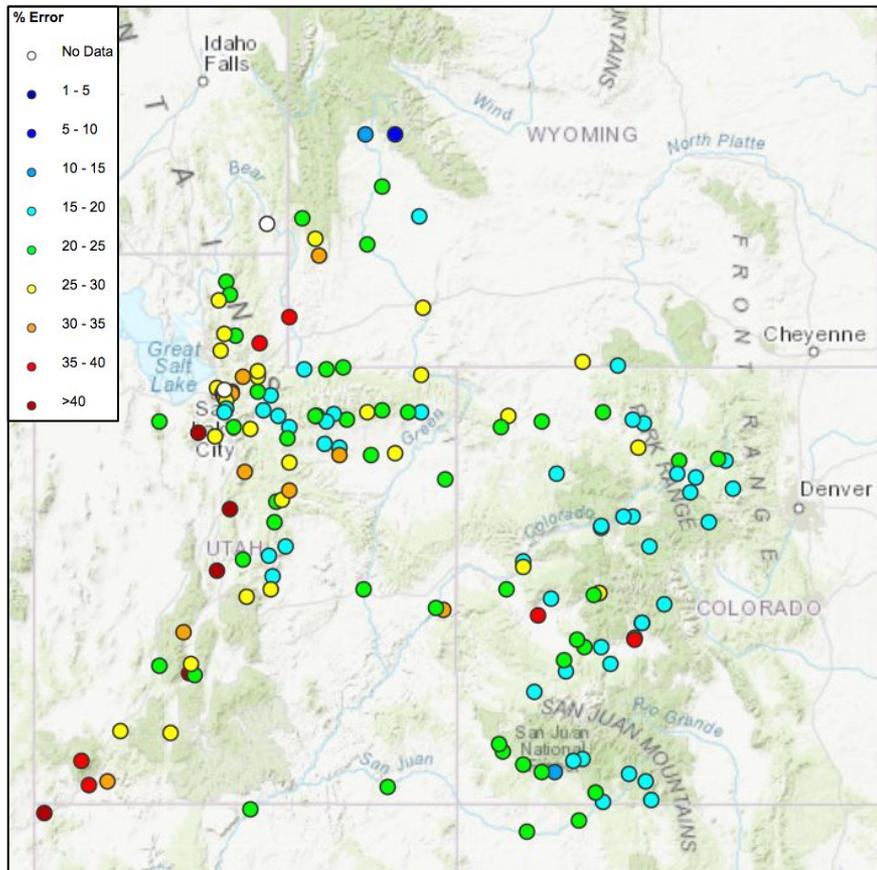


Summary

- Near record (very dry) antecedent soil moisture conditions entering the water year 2021 snow accumulation & runoff season
- Current snowpack (SWE) conditions are below to well below normal across the majority of the region
 - Early February is around 60% through the snow accumulation season
- February water supply forecasts (% of normal):
 - Upper Colorado: 35-80%
 - Lower Colorado: 20-65%
- Early February precipitation has benefited water supply guidance across northern basins
 - Forecasted precipitation amounts of 1.0-1.5 inches over the Upper Green, Yampa, and Upper Colorado River headwater basins over the next few days.
- Weather models beyond 7 days favoring slightly elevated odds for above normal precipitation across the north and below normal precipitation across the southern half of Utah/Colorado and the Lower Basin
- Given the dry conditions, an above normal snowpack or a wet spring will be needed to see near average water supply volumes.

CBRFC Hydro Science Update - Water Supply Forecast Errors

February Forecast Error: April-July Volume



Location

<u>Location</u>	<u>Avg Feb Forecast Error</u>
Green River - Warren Bridge	15%
Fontenelle Reservoir	25%
Yampa River - Deerlodge	25%
Blue River - Dillon Reservoir	17%
Colorado River - Cameo	19%
Blue Mesa Reservoir (Gunnison)	20%
McPhee Reservoir (Dolores)	25%
Navajo Reservoir (San Juan)	22%
Lake Powell	24%
Virgin River at Virgin	34%

Forecasts are better than just going with average
Error tends to decrease each month into the spring

Where Forecasts are Better:

- Headwaters, Primarily snow melt basins, known diversions / demands

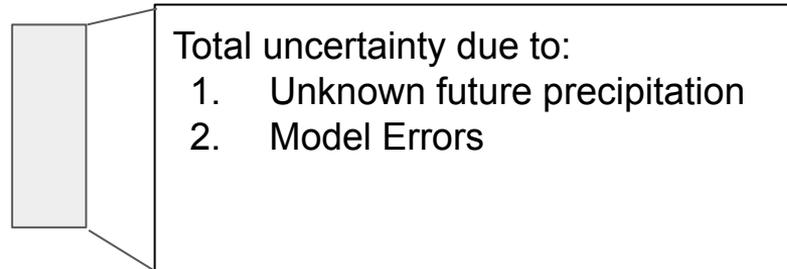
Where Forecasts are Worse:

- Lower elevations (rain or early melt), downstream of diversions / irrigation, little is known about diversions / demands

Excited about incorporating new science into forecast system and potential to improve forecasts -> ASO, etc.

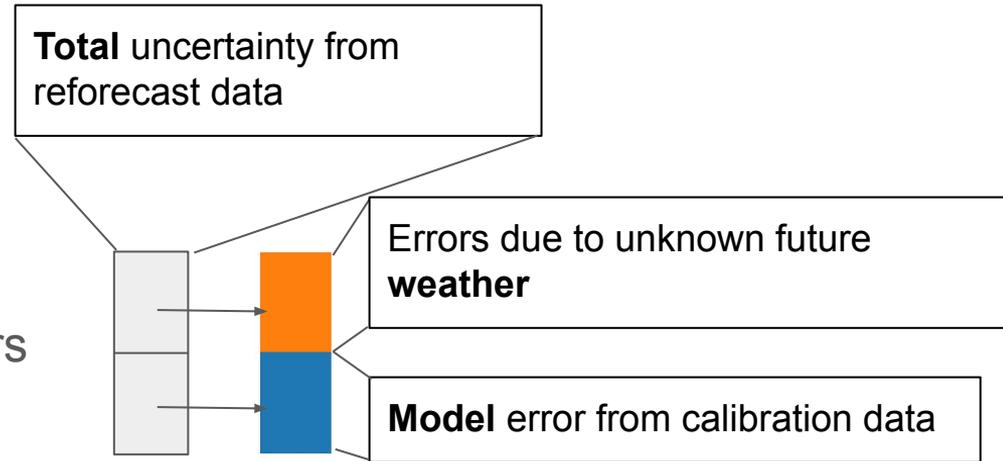
Water Supply Forecast Errors

- Uncertainty in water supply forecasts are a combination of **model errors** and unknown future **weather** (mostly April - July precipitation).
- We can quantify the total error in water supply forecasts by looking at 35 years of reforecast data.



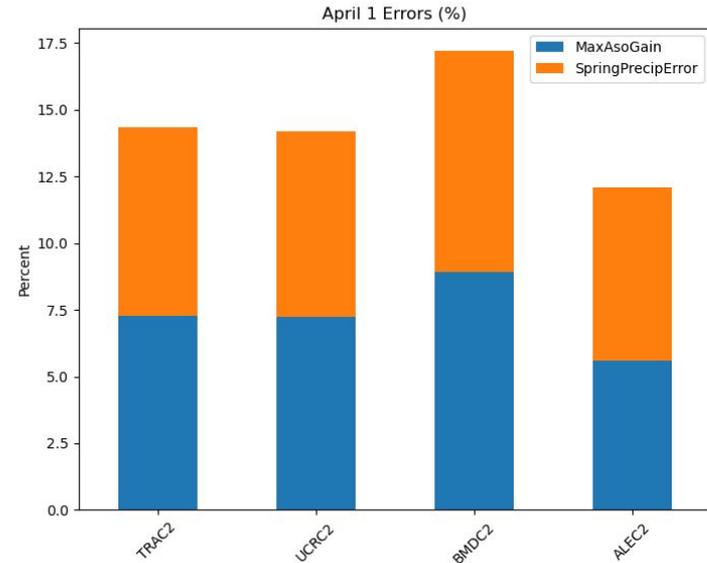
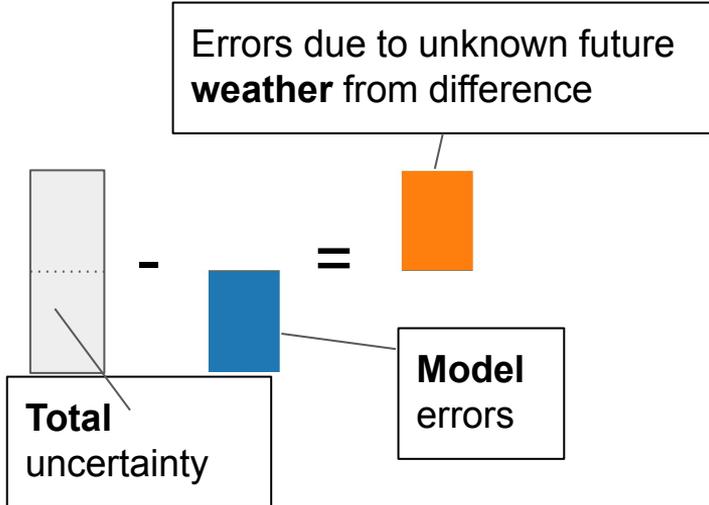
Water Supply Forecast Errors

- **Model** errors can be attributed to...
 - Errors in model soil moisture
 - Errors in model snow pack
 - Errors in model parameters
 - Errors in model structure
 - Etc.
- We can quantify total **model** errors by looking at 35 years of calibration data.



Water Supply Forecast Errors

- Uncertainty due to unknown future precipitation is obtained by differencing.
- On average, roughly half of the volume error in an April 1 Water Supply forecast is attributed to the unknown spring precipitation amount.
- The other half is due to model errors



Continual quest to improve our forecasts

CBRFC is always looking for ways to improve our forecasts

- Future Weather Uncertainty

- Seasonal to subseasonal weather prediction
- Global Climate Indices (El Nino vs. La Nina)

- Model Errors

- Improved calibrations - every 5 years
- New datasets/products to incorporate into our model

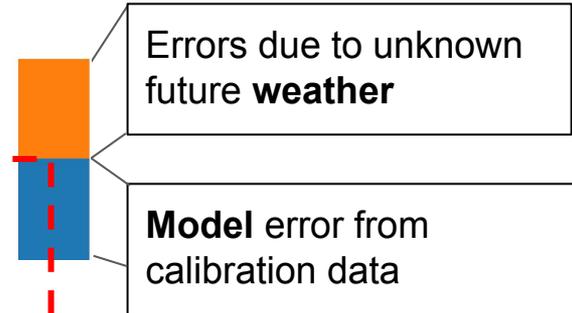
- External ET data sets

- External Snow Products

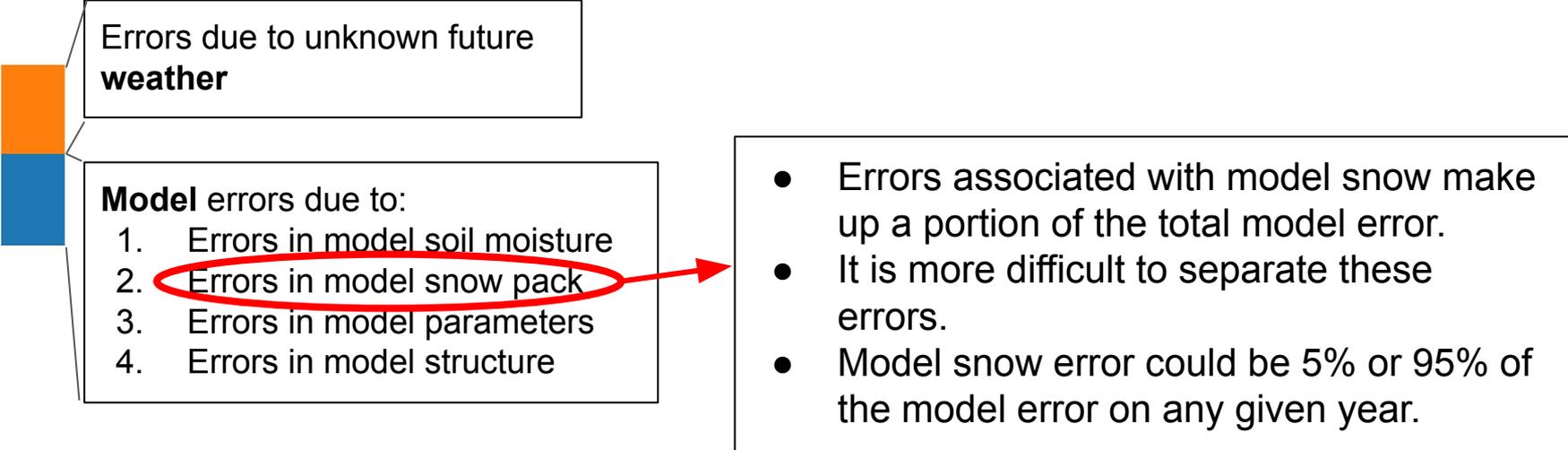
- MODIS - snow covered area, dust radiative forcing
- SWANN - Neural Network SWE product
- ASO - Airborne snow depth mapping and SWE estimation
- NOHRSC-SNODAS
- CU-JPL Real-Time Snowpack Estimations from Satellites

- Alternate models and methods

- Physically based snow models (UEB, iSnoBAL)
- Distributed Modeling - RDHM
- Data Assimilation
- Impacts of fires



Error associated with current snow conditions



Errors due to unknown future **weather**

Model errors due to:

1. Errors in model soil moisture
2. Errors in model snow pack
3. Errors in model parameters
4. Errors in model structure

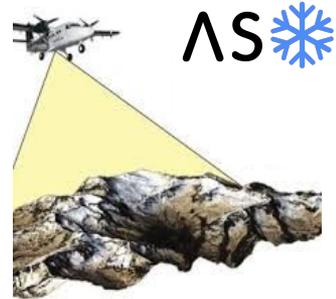
- Errors associated with model snow make up a portion of the total model error.
- It is more difficult to separate these errors.
- Model snow error could be 5% or 95% of the model error on any given year.

Potential for ASO in CBRFC Water Supply Forecasts

Background

ASO: Airborne Snow Observatory Inc.

ASO data: Estimated Gridded Snow Water Equivalent (SWE)



- Measured snow depth (airborne lidar)
- Estimated snow density (modeled, measured at points, combination)
- Gives an independent estimate of SWE in a basin or elevation zone

	2016	2017	2018	2019	2020	2021
Upper Gunnison			x	x	(x)	
Blue River				x		(x)
Uncompahgre	x	x				
Animas						(x)
Dolores						(x)

2018 and 2019 East at Almont - Gunnison

	Volume (kaf)		Snow Water Equivalent (in)		
	Calibration	Observed	Zone	Calibration	ASO
Mar 31, 2018	89	77	11000'-14216'	18.6	15.0
	Over simulated	Dry year: 42% avg	9500'-11000'	7.3	8.3
			8016'-9500'	0.8	1.6
Apr 7, 2019	235	269	11000'-14216'	36.7	36.6
	Under simulated	Wet year: 148% avg	9500'-11000'	18.8	22.4
			8016'-9500'	9.4	9.1

Summary

- CBRFC is continually trying to improve forecasts.
- Water supply errors are a combination of model errors and unknown future weather errors.
- We are optimistic about the potential for incorporating ASO data and other external snow products to improve forecasts.

More data is needed for a better assessment of ASO

- Current spatial extent covers 3-6 basin zones (1-2 basins) per flight
 - May need to extrapolate limited areal extent to additional basins
- We have a maximum of 2 years of data over the same basin (soon to be 3?).
- It would benefit CBRFC to have repeat flights in the same basin.

2021 Water Supply Webinar Schedule

**All Times Mountain Time (MT)*

Colorado River Basin

Friday	Jan 8th	10 am
Friday	Feb 5 th	10 am
Friday	Mar 5 th	10 am
Wednesday	Apr 7 th	10 am
Friday	May 7 th	10 am

Great Basin

Friday	Jan 8th	11:30 am
Friday	Feb 5 th	11:30 am
Friday	Mar 5 th	11:30 am
Wednesday	Apr 7 th	11:30 am
Friday	May 7 th	11:30 am

Peak flow forecast webinar Thursday, March 18th, 10 am MT

Additional briefings scheduled as needed

Webinar schedule & registration information has been posted to the CBRFC web page



COLORADO BASIN RIVER FORECAST CENTER

NATIONAL WEATHER SERVICE / NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



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News Thursday December 17, 2020, 1:00 pm MT: CBRFC Early Season Water Supply Outlook Webinar. Register for the 2021 Water Supply Forecast Webinar Schedule and Registration -> [More Info...](#)

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subject line: **email notification list**

This list is used to provide notification when webinars are scheduled, water supply forecasts are updated, and for other news of interest to our stakeholders regarding CBRFC operations.

CBRFC Water Supply Forecast Webinar Schedule & Registration - Water Year 2021

The Colorado Basin River Forecast Center (CBRFC) produces water supply forecasts for the Colorado River Basin and the east. CBRFC conducts December through May webinars explaining the forecasts and current conditions.

Follow the links below to register for a webinar.

Early Season Water Supply Outlook Webinar
[Thursday Dec 17 @ 1 pm MT](#)

Colorado River Basin Water Supply Webinars
[Friday January 8th @ 10 am MT](#)
[Friday February 5th @ 10 am MT](#)
[Friday March 5th @ 10 am MT](#)
[Wednesday April 7th @ 10 am MT](#)
[Friday May 7th @ 10 am MT](#)

Utah Water Supply Webinars
[Friday January 8th @ 11:30 am MT](#)
[Friday February 5th @ 11:30 am MT](#)
[Friday March 5th @ 11:30 am MT](#)
[Wednesday April 7th @ 11:30 am MT](#)
[Friday May 7th @ 11:30 am MT](#)

Peak Flow Webinar
[Thursday March 18th @ 10 am MT](#)

A notification email will be sent if a date or time change occurs. Additional webinars are scheduled as needed. The webinar slides will be available from the [CBRFC presentations page](#) soon after each briefing.

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CBRFC Water Supply Presentations

<https://www.cbrfc.noaa.gov/present/present.php>

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