NOAA
National
Weather
Service

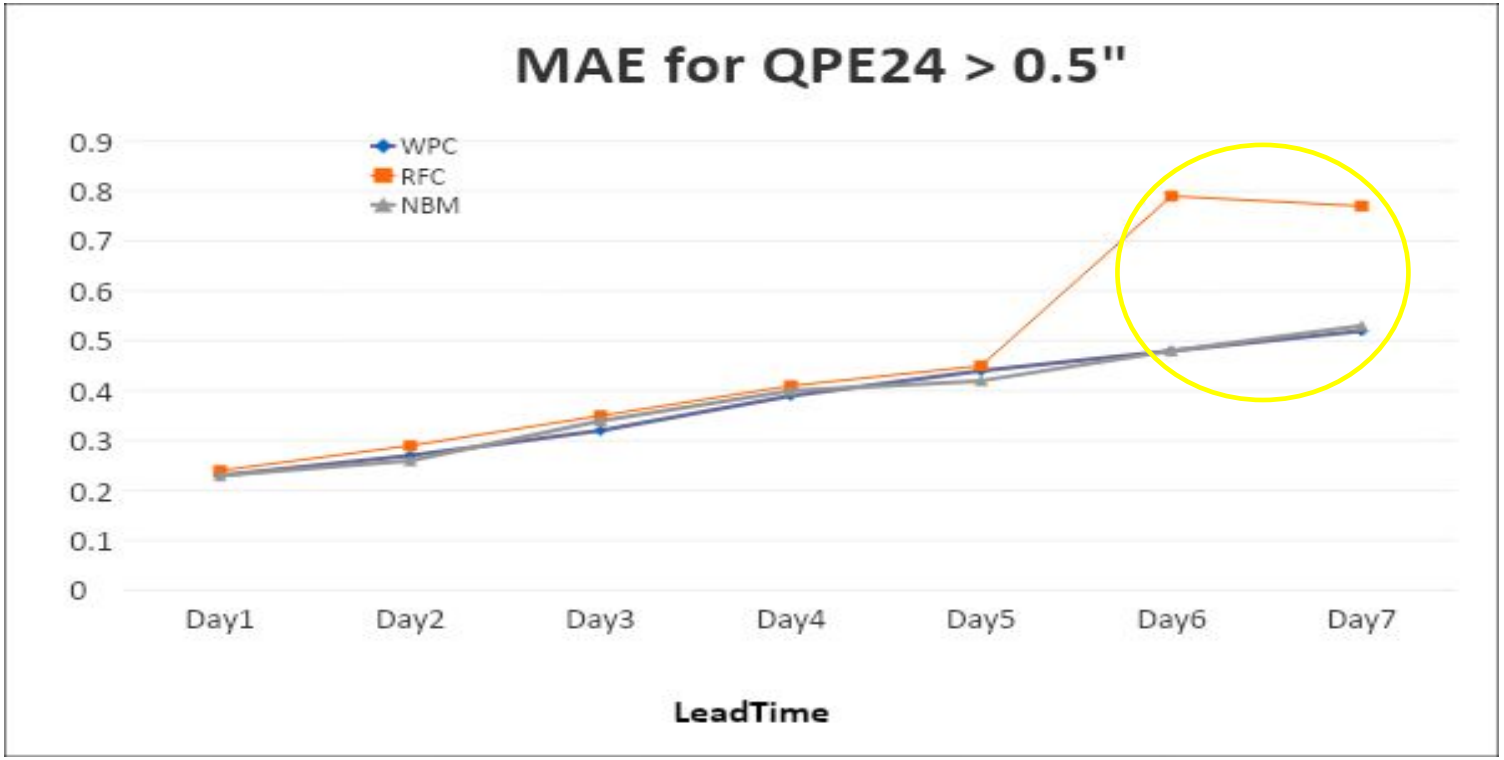
CBRFC Operations Update
Water Year 2021

Colorado River Forecasting Service (CRFS) Meeting
November 24, 2020

CBRFC WY21 Operations Update

- ESP trace files update
- Using 7-day forecast precipitation (QPF) in ESP and daily forecast
- Lower Colorado River Basin ENSO trace weighting
- 1991-2020 normals update
- Hydrologic model calibration update
- Basin focal points for WY21

QPF Verification over UCRB



- By forecasting QPF=0 on Days 6/7 and not using WPC, *overall* we are missing out (note big jump in error).

Now Using 7 days of QPF in Upper Basin

- *Verification indicates that using WPC QPF for Days 6/7 is more accurate than forecasting zero QPF. This is especially true during the wet months (Oct-May).*

***Changes as of Fall 2020**:*

1) Switch to using **WPC for Days 6/7 QPF** in the *Upper Basin and Great Basin* in our daily operational model. We still use QPF=0 for Days 8-10.

2) Use **seven** days of QPF/QTF in our ESP run that incorporates QPF (**ESP w/QPF**). Previously we were only using five days.

Summary of WY21 Forecast Model Forcings

PRODUCT	TEMPERATURE	PRECIPITATION
10 & 15 DAY FLOW FORECAST	Days 1-10: NBM Days 11-15: climatology	Days 1-7: WPC Days 8- : zero precip
ESP NO QPF	All days: climatology	All days: climatology
ESP WITH QPF	Days 1-7: NBM Days 8- : climatology	Days 1-7: WPC Days 8- : climatology

NBM: National Blend of Models
WPC: Weather Prediction Center

Climatology Periods (Based on most recent model calibration)
Upper Colorado: 1981-2015
Lower Colorado: 1981-2020
Great Basin: 1981-2015

Lower Basin ENSO Weighting Scheme

Develop an ENSO statistical weighting scheme for Lower Basin water supply basins (Gila, Salt, Verde, Virgin) that optimizes skill increase over our current ESP method of equally weighting every trace.

	GLHA3 *Gila*	SLRA3 *Salt*	VDTA3 *Verde*	VIRU1 *Virgin*
EQSOI	-0.42 Nov	-0.49 Nov	-0.44 Nov	-0.35 Nov
EQSOI_3mean	-0.39 OND	-0.45 OND	-0.42 OND	-0.29 SON
MEI	0.44 ND	0.46 ND	0.45 ND	0.29 ND
NAO	0.36 Aug	0.34 Aug	0.28 Nov	0.2 Aug
NINO12_anomaly	0.3 Dec	0.32 Dec	0.31 Dec	0.33 Dec
NINO3_anomaly	0.3 Dec	0.35 Dec	0.34 Dec	0.29 Dec
NINO34_anomaly	0.34 Dec	0.37 Dec	0.37 Dec	0.27 Dec
NINO4_anomaly	0.34 Jul	0.33 Dec	0.34 Dec	0.26 Dec
ONI	0.33 MJJ	0.34 OND	0.32 OND	0.23 OND
PNA	-0.24 Dec	-0.31 Dec	-0.24 Dec	-0.28 Dec
PDO	0.29 Oct	0.29 Sep	0.25 Sep	0.23 Sep
SOI	-0.42 Nov	-0.45 Nov	-0.43 Nov	-0.34 Nov
SOI_standardized	-0.47 Oct	-0.46 Oct	-0.44 Nov	-0.34 Nov
SOI_standardized_3mean	-0.47 OND	-0.48 OND	-0.45 OND	-0.29 OND
TNI	-0.18 DJF	-0.16 DJF	-0.22 DJF	-0.27 DJF

Correlation coefficient (r) between teleconnection index and Jan-May runoff

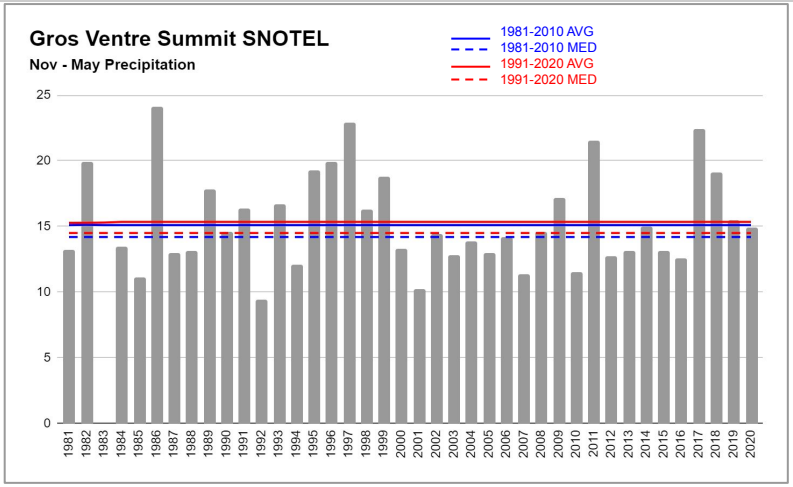
1991-2020 Normals Update

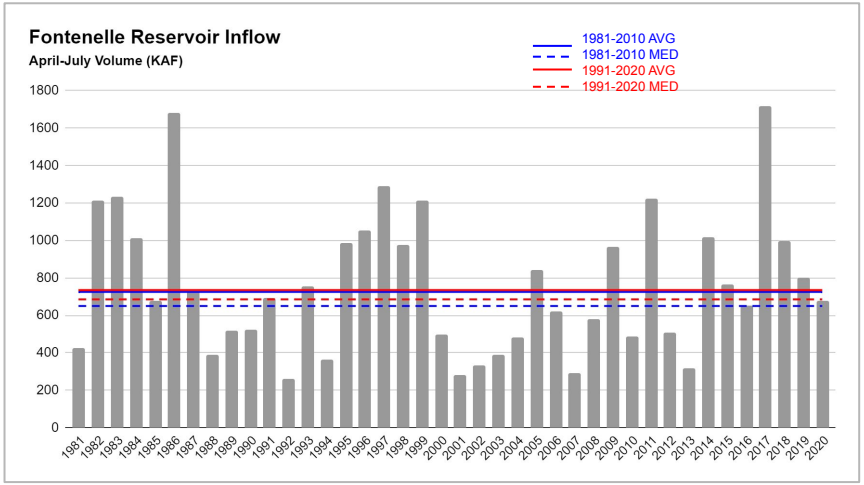
- New averages are coordinated with partner agencies (NRCS and BOR).
  - Review of unregulated equations
  - Reality check
  - Numbers don't need to match but do need to understand why

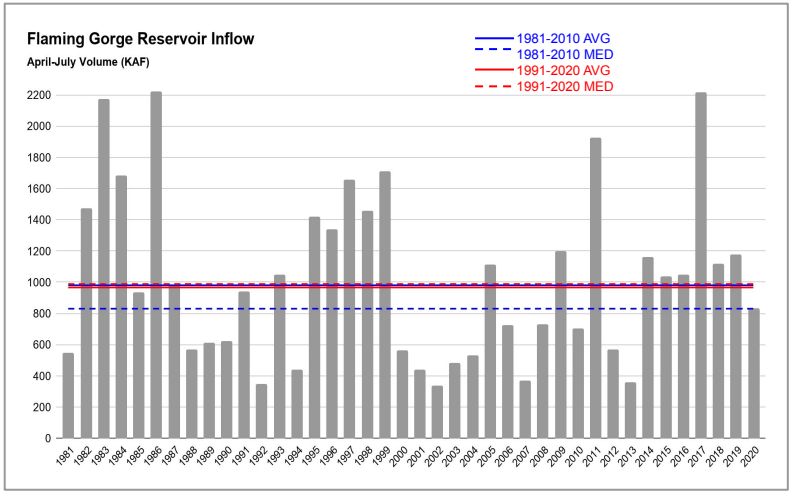
- New averages and calibrations will be implemented in WY22.
  - 1991-2020 will be used for new 30 year averages.
  - Official ESP period is still to be determined.
  - Recalibration of Upper Colorado River basins to the 1981-2020 period.
  - Recalibration of the Great Basin may extend into WY22; implemented in WY23.

- WY21
  - Upper Basin: No changes
    - 1981-2010 for averages
    - 1981-2015 ESP
  - Lower Basin:
    - 1981-2010 for averages
    - 1981-2020 ESP

1991-2020 Normals: Upper Green River Basin

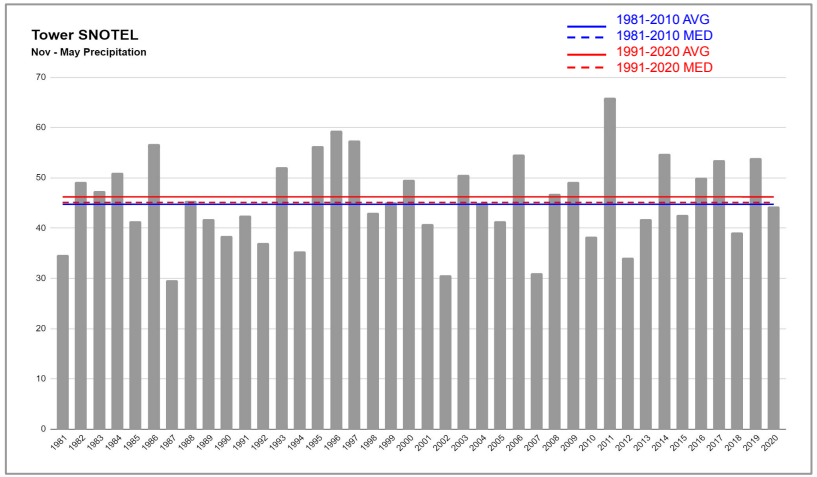


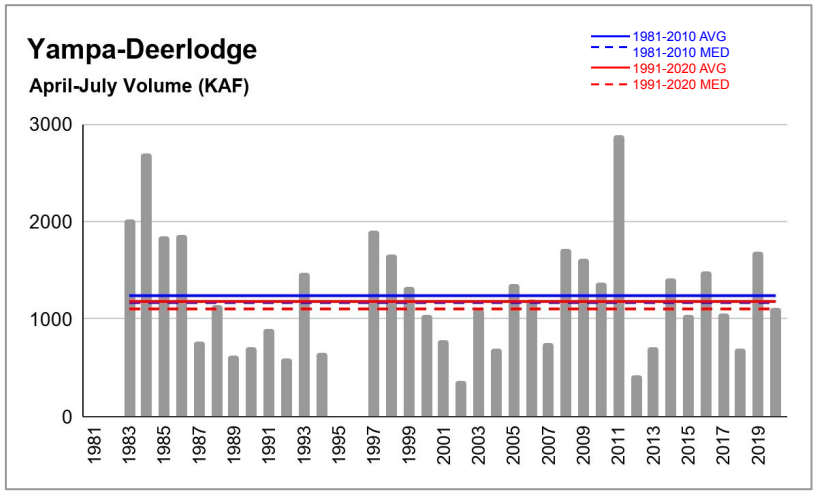




	Average			Median		
	81-10	91-20	% Diff	81-10	91-20	% Diff
Precip (in)	15.1	15.3	+1%	14.2	14.5	+2%
Fontenelle (KAF)	725	735	+1%	650	685	+5%
Flaming Gorge (KAF)	980	966	-1%	830	988	+19%

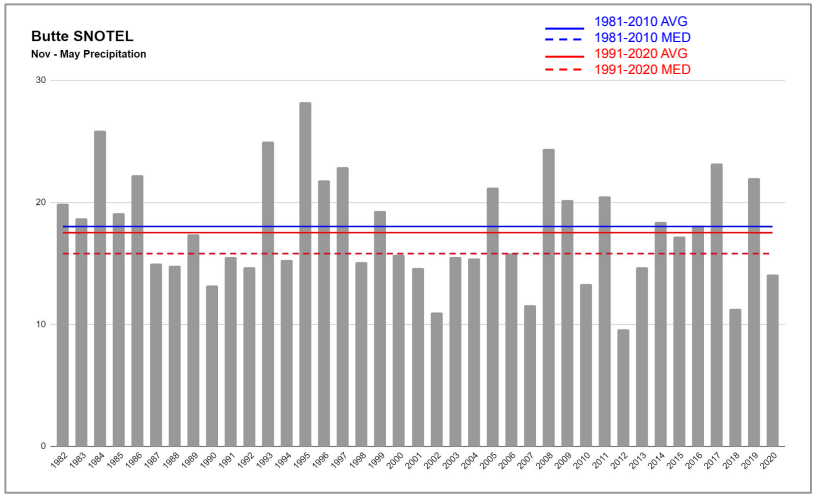
1991-2020 Normals: Yampa River Basin

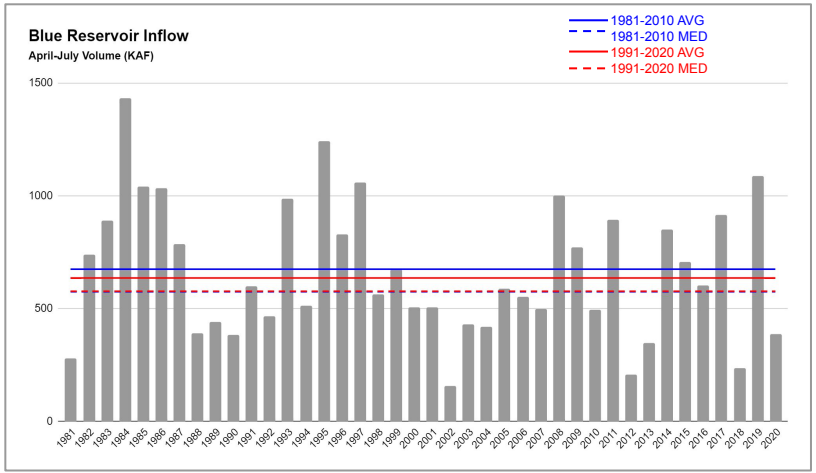




	Average			Median		
	81-10	91-20	% Diff	81-10	91-20	% Diff
Precip (in)	44.8	46.2	+3%	45.1	45.1	0%
Yampa-Deerloge (KAF)	1240	1180	-5%	1170	1104	-6%

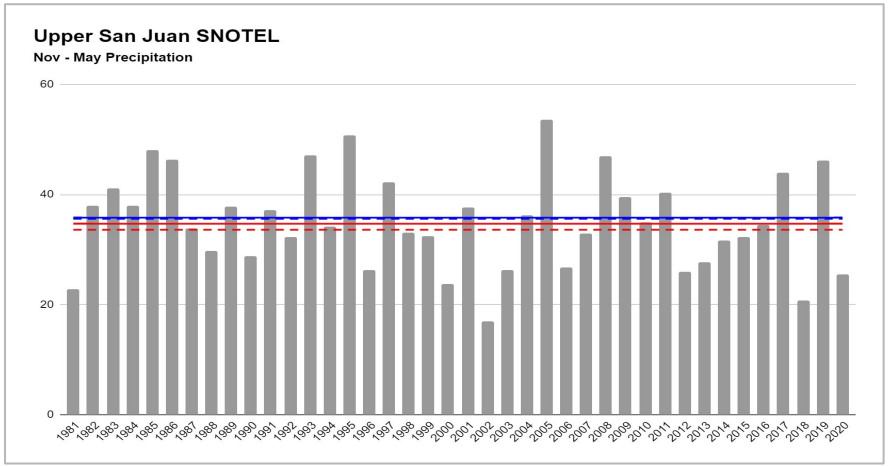
1991-2020 Normals: Gunnison River Basin

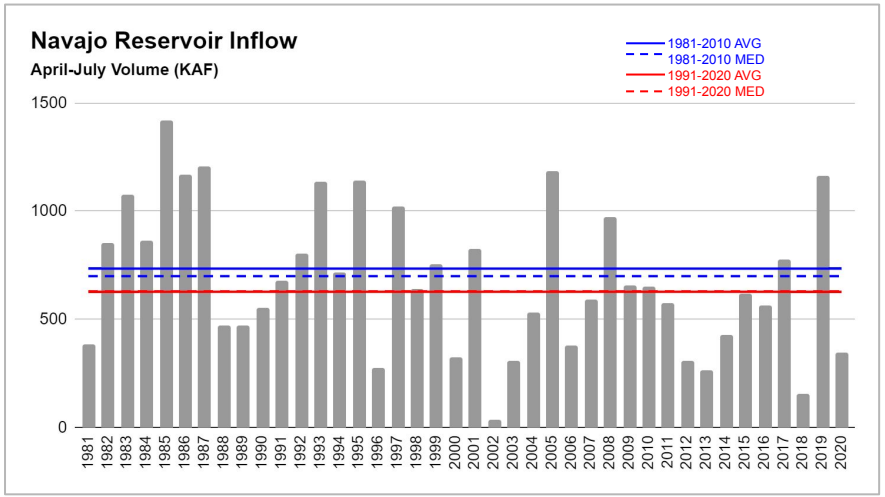




	Average			Median		
	81-10	91-20	% Diff	81-10	91-20	% Diff
Precip (in)	18	17.5	-3%	15.8	15.8	0
Blue Mesa (KAF)	675	636	-6%	575	575	0

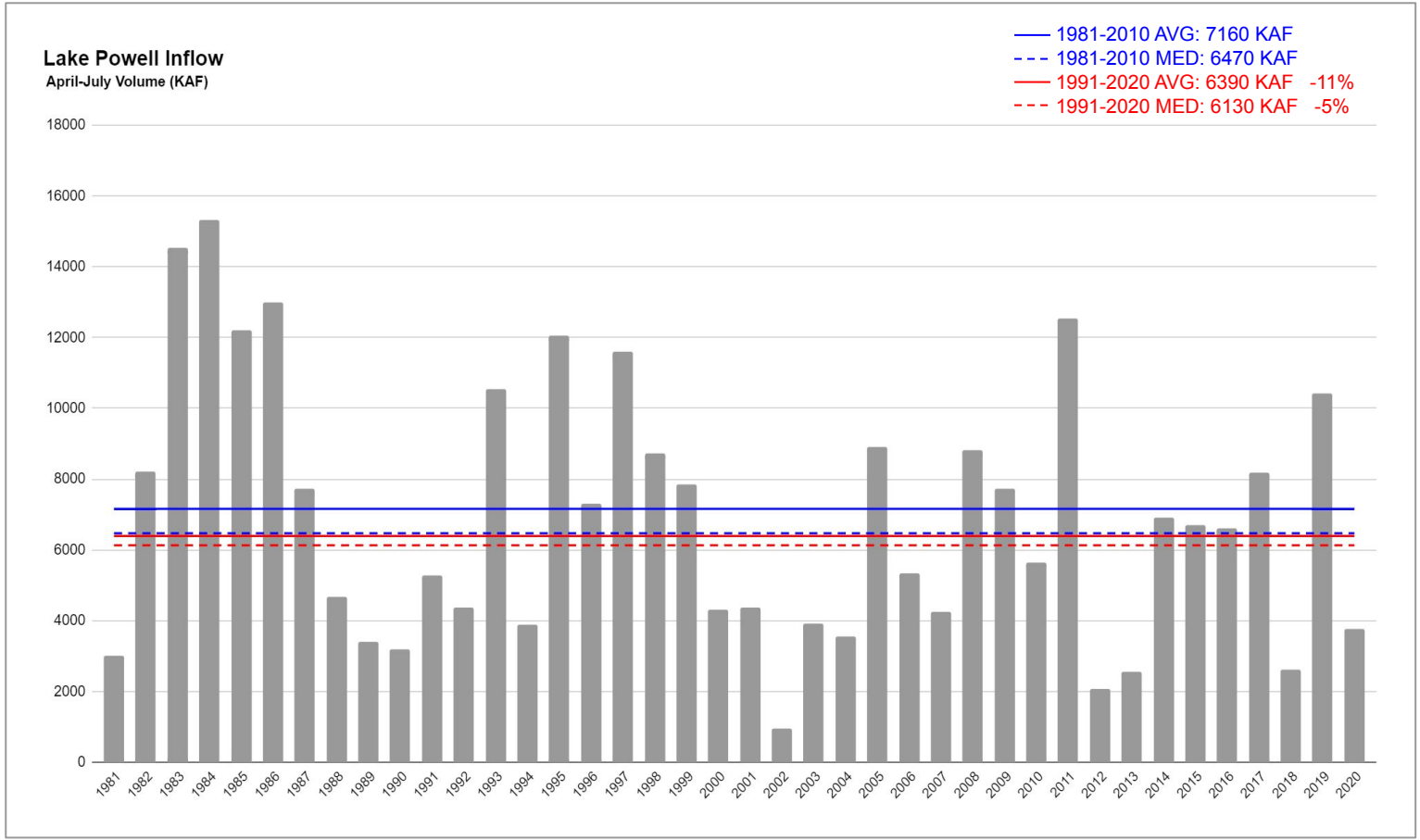
1991-2020 Normals: San Juan River Basin



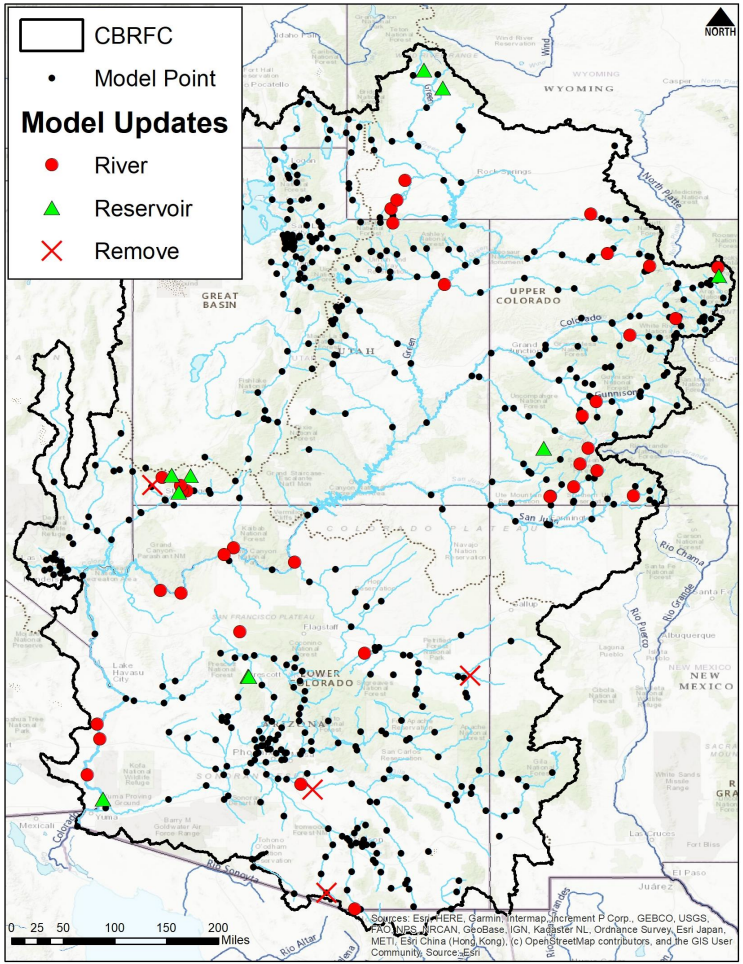


	Average			Median		
	81-10	91-20	% Diff	81-10	91-20	% Diff
Precip (in)	35.8	34.7	-3%	35.6	33.6	-6%
Navajo (KAF)	735	628	-15%	700	630	-10%

1991-2020 Normals: Lake Powell Inflow



CBRFC Model Basin Additions



Upper Colorado River Basin List

HB5	DESCRIPTION	FGROUP	WFO
RIOC2	RIO BLANCO - MOUTH- TRUJILLO- NR	San Juan	GJT
VNBC2	VALLECITO CK - BAYFIELD- NR	San Juan	GJT
ANBC2	ANIMAS - SILVERTON- BLO	San Juan	GJT
ATTC2	ANIMAS - TALL TIMBER RESORT- TACOMA- ABV	San Juan	GJT
DGOC2	ANIMAS - DURANGO PUMP PLANT- BLO	San Juan	GJT
CYKC2	CHERRY CREEK - MOUTH- RED MESA- NR	San Juan	GJT
LPCC2	LA PLATA - CHERRY CK- BLO- RED MESA- NR	San Juan	GJT
GRHC2	GROUNDHOG RESERVOIR	Dolores	GJT
CMNC2	CIMARRON - SQUAW CK- BLO- CIMARRON- NR	Gunnison	GJT
COWC2	COW CK - RIDGWAY RESERVOIR- NR	Gunnison	GJT
YCAC2	YAMPA - LAKE CATAMOUNT- ABV	Yampa	GJT
MCYW4	MUDDY CK - YOUNG DRAW- BLO- BAGGS- NR	Yampa	CYS
YAHC2	YAMPA - ELKHEAD CK- ABV- HAYDEN- NR	Yampa	GJT
BAKC2	COLORADO - BAKER GULCH- BLO- GRAND LAKE- NR	UC Main	BOU
SMRC2	COLORADO - SHADOW MTN RES- GRAND LK- NR	UC Main	BOU
EMMC2	ROARING FK - EMMA- NR	UC Main	GJT
GORC2	GORE CK - MOUTH- MINTUR- NR	UC Main	GJT
BLKW4	BOULDER LAKE	Upper Green	RIW
NFAW4	NEW FORK LAKE	Upper Green	RIW
FLRW4	FREMONT LAKE	Upper Green	RIW
EFSU1	EAST FORK SMITHS FORK - CHINA MEADOWS	Upper Green	SLC
SMFW4	SMITHS FORK - ROBERTSON- NR	Upper Green	SLC
SFMW4	SMITHS FORK - MOUNTAIN VIEW	Upper Green	SLC
MCHW4	MUDDY CK - HAMPTON-NR	Upper Green	SLC
GROU1	GREEN - OURAY- NR	Lower Green	GJT

CBRFC Model Diversion Additions

- Uncompahgre River
  - New diversion data below Ridgway Dam
  - Will replace calibrated irrigation with Colorado DWR gages on diversions
  - Return flow will still be unknown/calibration

- Duchesne River
  - New diversion data on Lake Fork, Yellowstone and Uinta Rivers
  - Will replace calibrated irrigation on the lower Duchesne River

- Upper Green
  - Above New Fork- Big Piney (potential improvement to Fontenelle forecast)
  - Blacks Fork abv Little America
    - Could potentially help Flaming Gorge local forecast
    - Will depend on time if it will be implemented in WY22 but work will be ongoing

Hydrologic Model Adjustments & Improvements
Global Changes

- Reduce ET above treeline
  - Improve model under simulation in back to back dry years

- Explore using a more physically based ET dataset (Hobbins) in calibration process
  - Uses North American Land Data Assimilation System (NLDAS) met variables
  - Penman based equation, CONUS-wide gridded coverage, 1979-2018 dataset

- Reduce precipitation in higher elevations
  - From prelim ASO research, these areas appear to have a wet bias in CBRFC model

- Use 1991-2020 PRISM climatology for station weighting/water balance, if available

- Achieve more regional/spatial consistency in hydrologic model parameters

Hydrologic Model Adjustments & Improvements
Snow

- Incorporate more SNOTEL stations into the calibration process
  - Longer POR; gather data and assess using trend/double mass analysis

- Above 8,000 ft, only use SNOTELS in MAP weighting calculations
  - Will allow 2x/monthly model snow updates to be consistent in all significant zones
  - Use more reliable historical precipitation dataset

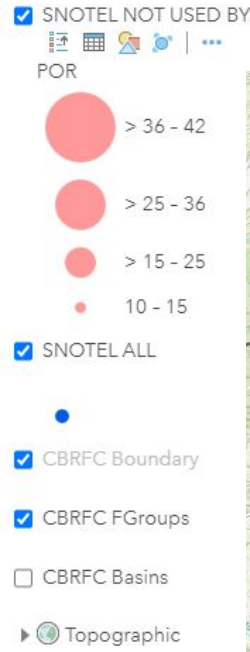
- Update dust on snow MAT adjustment procedure using 2000-2020 dataset

- Use historical snow cover grids (MODIS) to help develop areal extent curves

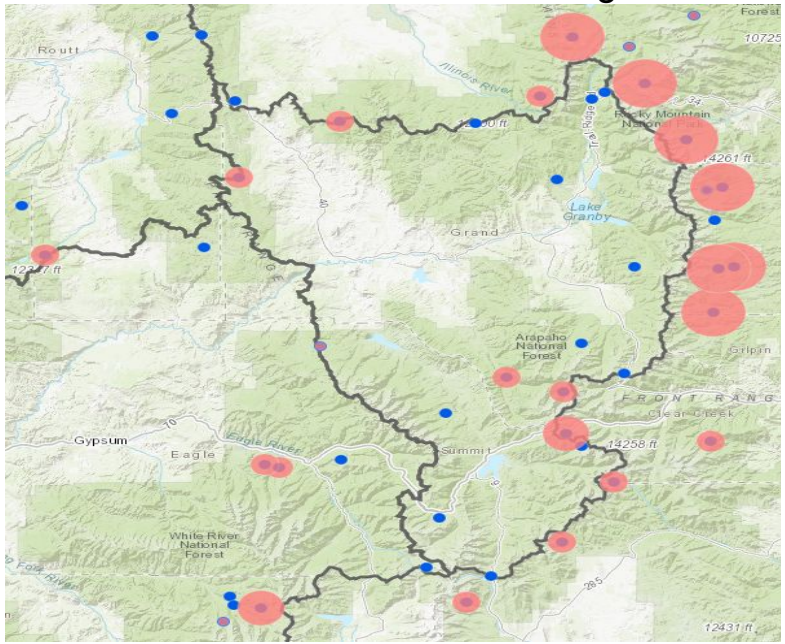
- Account for winter sublimation in coniferous forest
  - Improve simulation in middle elevation zones (8500-11000)

- Improve existing/develop new tools to automate above processes

SNOTEL Station Period of Record (POR) Analysis



Snapshot of spatial analysis in UC main/headwater region



List of new SNOTEL Candidates

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

Usability will be determined during calibration QC/trend analysis process

Summary

- 1981-2020 CBRFC model calibration update will require significant work & time
  - New averages and calibrations will be implemented in WY22
  - Preliminary data suggest averages will:
    - Increase or stay similar in the Upper Green, Yampa and parts of the Upper Colorado mainstem.
    - Decrease in the Gunnison, Dolores and San Juan.
    - North to South decreasing trend
  - Official ESP period TBD

- Exploring numerous ways to improve CBRFC hydrologic model
  - Large focus on ET, snow, new science/datasets
  - Water balance analysis crucial
  - Calibration goal: reduce error on all time scales (daily/monthly/seasonal)

- Expecting modest improvements in hydrologic model simulations

Water Year 2021 Basin Focal Points

Michelle Stokes - Hydrologist In Charge

John Lhotak - Development and Operations Hydrologist

Paul Miller - Service Coordination Hydrologist

Cass Goodman - Computer Systems Analyst

Valerie Offutt - Administrative Assistant

Cody Moser - Upper CO and Gunnison

Ashley Nielson - San Juan, Dolores, Powell, Upper Green, and Yampa

Patrick Kormos - Weber, Duchesne, Lower Green, and Provo

Brent Bernard - Bear, Sevier, Six Creeks

Zach Finch - Lower Colorado River Basin

Brenda Alcorn - Senior Hydrologist

Craig Peterson - Senior Hydrometeorologist

Tracy Cox - Hydrometeorologist

Extra Slides

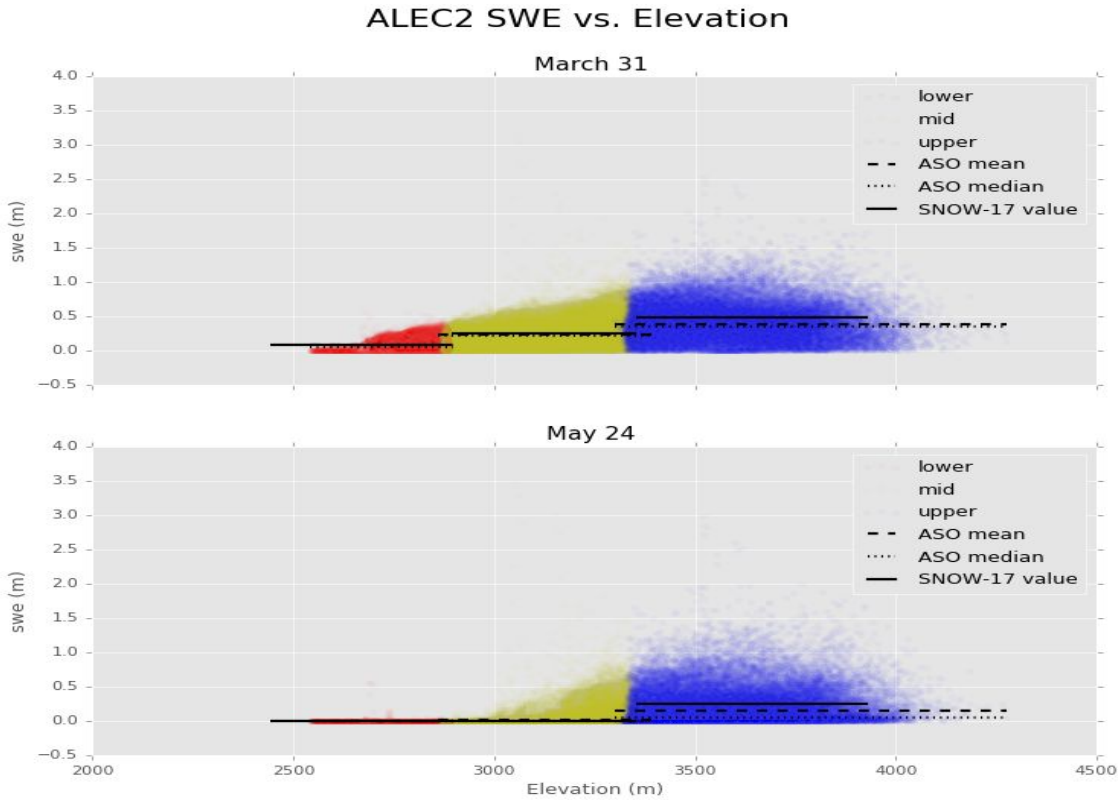
NASA ASO (Airborne Snow Observatory)

- ASO primary products are snow albedo, snow depth, and snow water equivalent (SWE)
  - Data collected during airborne flights using imaging & lidar technology

- Preliminary CBRFC ASO findings:
  - ASO estimates less water stored as snow at the highest elevation zones (above 11,000 ft) when compared to SNOW-17 modeled snow
    - Based on analysis using a limited number (3 flights across 4 basins) of ASO flights over the Gunnison River Basin in Colorado
      - 2018 (dry year): March 31 & May 24
      - 2019 (wet year): April 8
  - Investigate effects of decreasing historical precipitation in high elevation model areas
    - Model performance
    - Water balance analysis
  - Continue analyzing future ASO flights within CBRFC domain and determine any trends

Prelim ASO Findings: Gunnison River Basin

- Findings consistent across 4 study basins:
  - ASO / CBRFC SWE comparable in lower/middle elevations
  - ASO SWE lower than CBRFC SWE in higher elevations



Dust on Snow

- CBRFC has been using snow contamination grids in forecast operations:
  - Procedure calculates temperature adjustment factor using coefficient determined during the calibration process
  - in San Juan River Basin only
    - Model calibration improvements were found using 2000-2010 period
      - Significant improvement in the timing of the snowmelt in basins with larger areas above tree line
      - Minimal effect on runoff volume
    - Other areas did not show a significant enough improvement to implement

- Collect & process snow contamination grids through 2020
  - Determine if current procedure can be applied in additional basins to improve streamflow forecasts

Historical MODIS Snow Cover Grids
SNOW-17 Areal Extent Parameterization

- Process and database historical dataset:
  - Raw & canopy corrected snow covered area
  - Assign quality codes based on percentage of useable pixels

- Generate MODIS observed historical (2000 - 2018) daily snow covered area time series for all hydrologic model zones

- Compare observed snow cover with model snow cover during the SNOW-17 model calibration/parameterization process