CBRFC 30 Year Average and Recalibration Update

Outline

- 30 Year Average Update
- Model Basin Additions
- Model Diversion Additions
- Hydrologic Model Improvements

30 Year Average Update

- 30 year averages are updated once every 10 years

- The CBRFC model is also fully recalibrated at the same time of the average update.
  - Current Upper Colorado: 175 segments, 44 reservoirs → ~450 zones
  - Current Great Basin: 83 segments, 22 reservoirs → ~170 zones
  - Current Lower Colorado: 220 segments, 31 reservoirs → ~550 zones

- Data and time intensive process
  - Historical Data Collection and Quality Control
    - Temperature and Precipitation
    - Steamflow and Diversion
    - Reservoir
  - Provisional agency data typically gets finalized during WY21.
  - New calculations of unregulated flow

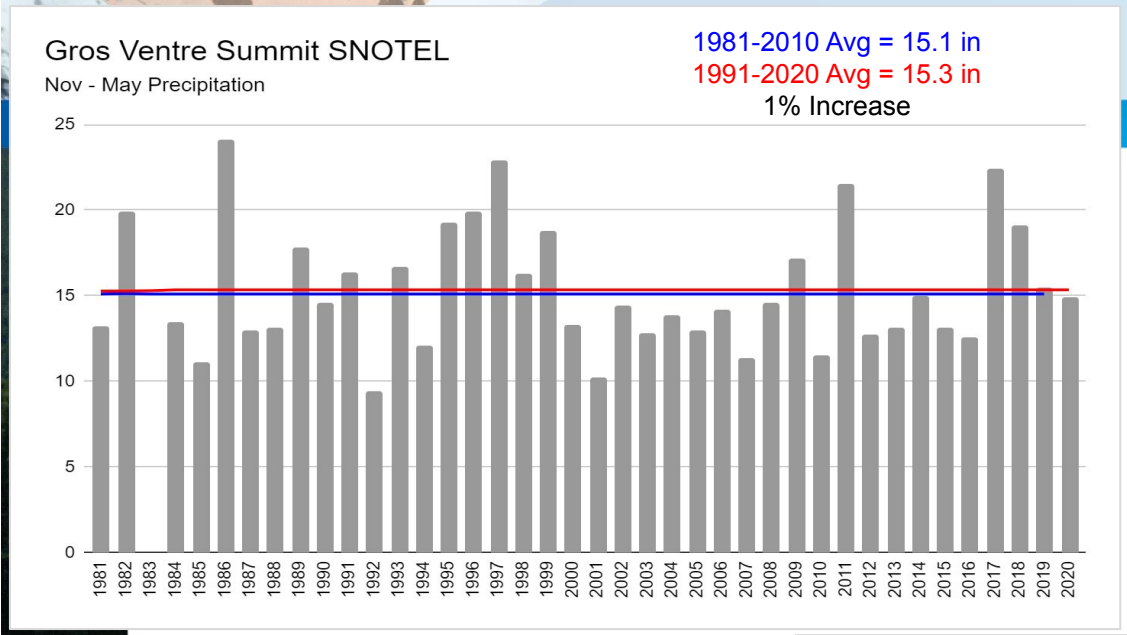
30 Year Average Update

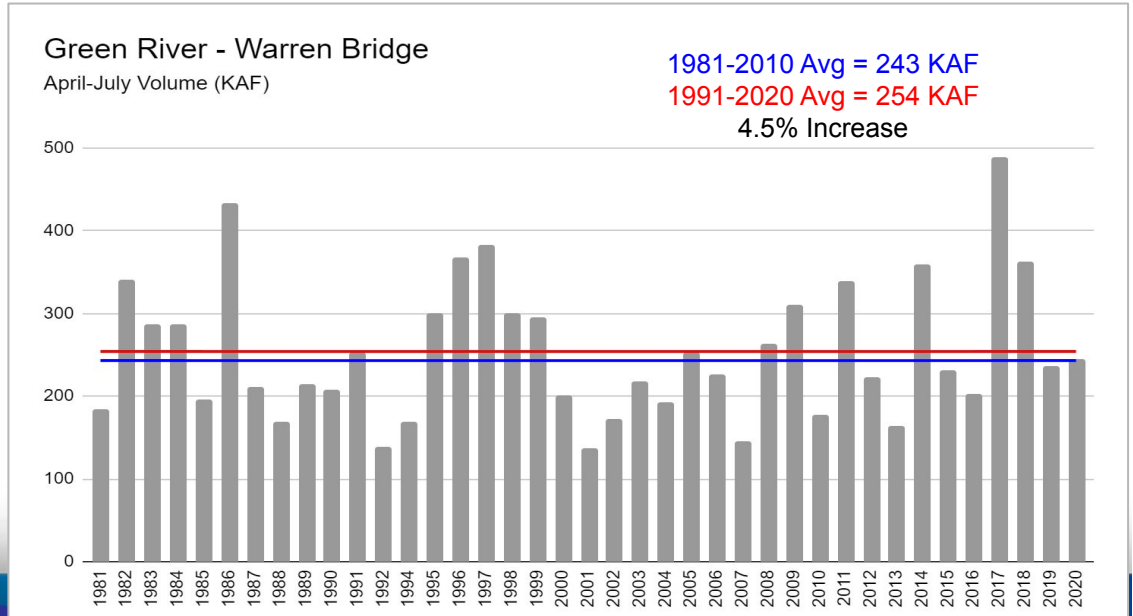
- New averages are coordinated with partner agencies (NRCS and BOR).

- 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

30 Year Average Update
Upper Green River Basin





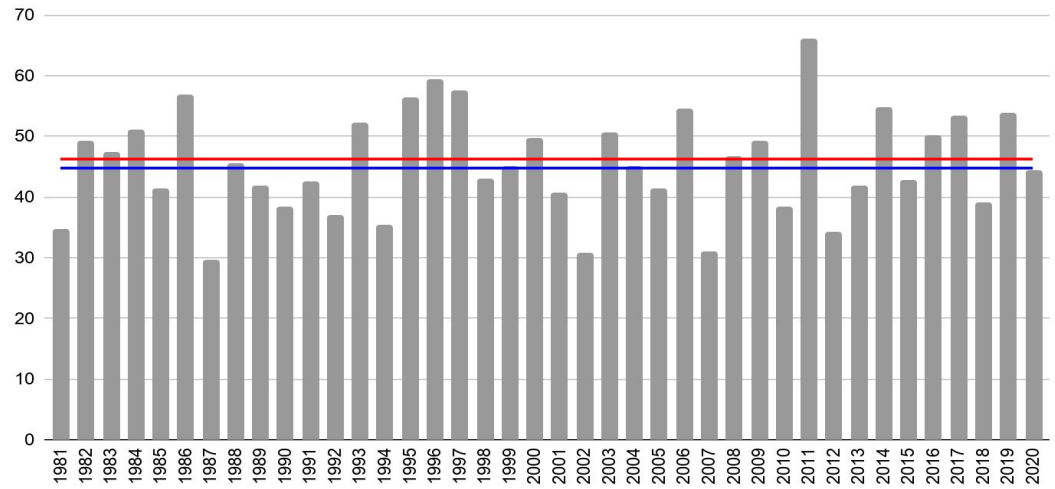
**Provisional Data*

30 Year Average Update
Yampa River Basin

Tower SNOTEL

Nov - May Precipitation

1981-2010 Avg = 44.8 in
1991-2020 Avg = 46.2 in
3% increase

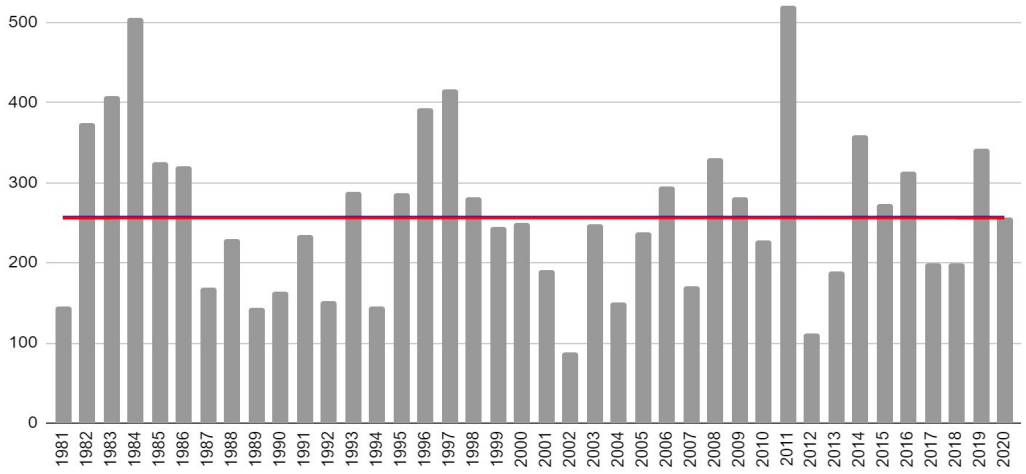


*Provisional Data

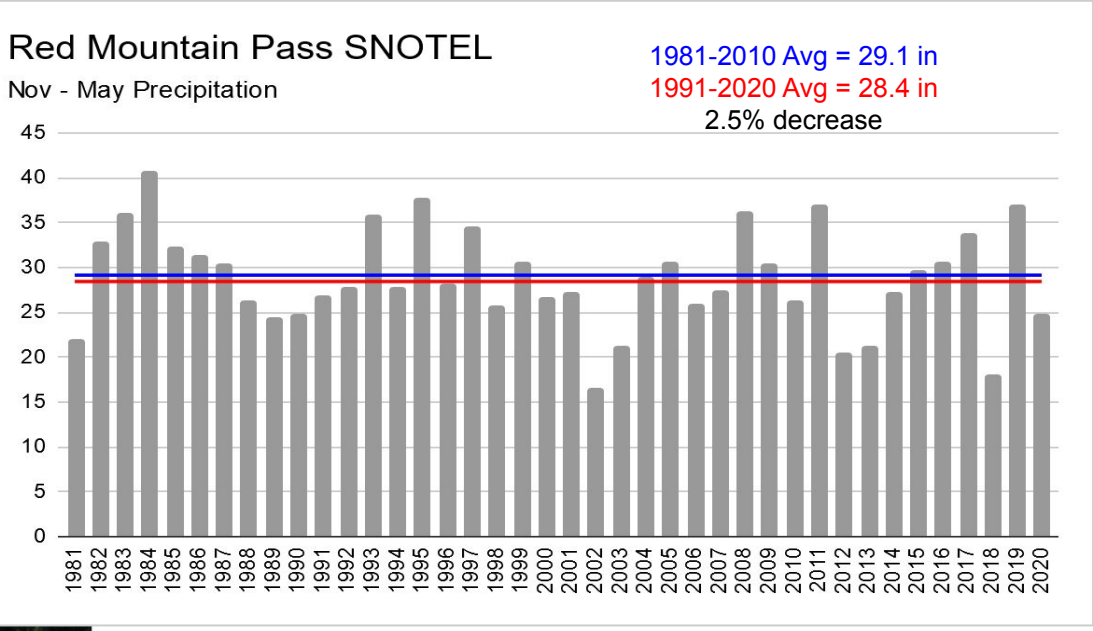
Yampa - Steamboat Springs

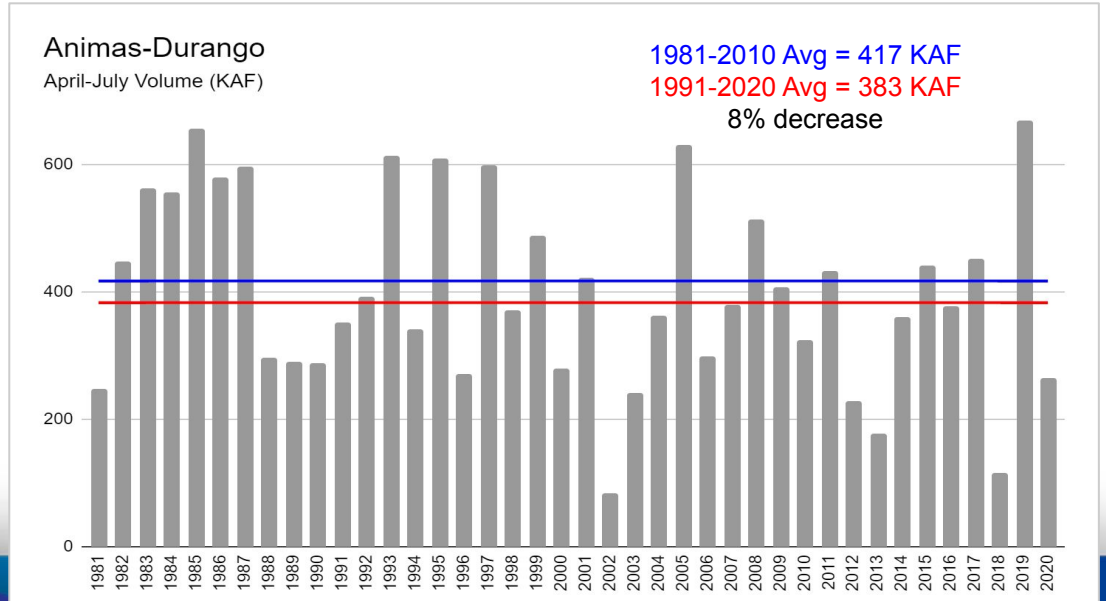
April-July Volume (KAF)

1981-2010 Avg = 257 KAF
1991-2020 Avg = 256 KAF
<1% decrease



30 Year Average Update
San Juan River Basin





**Provisional Data*

CBRFC Model Basin Additions

- Ongoing process:
  - New basin requests from stakeholders/CBRFC staff
  - Determine who maintains the stream gage and status of gage support in the future (funding)
  - Basin delineation / GIS analysis
  - Collect/QC historical streamflow data
  - Basin research (irrigation/diversions/etc.)
  - Station (temp/precip) selection & weighting
  - Model calibration / water balance analysis
  - Model configuration / implementation into forecast operations
  - Database / web configuration
  - Documentation / maintenance

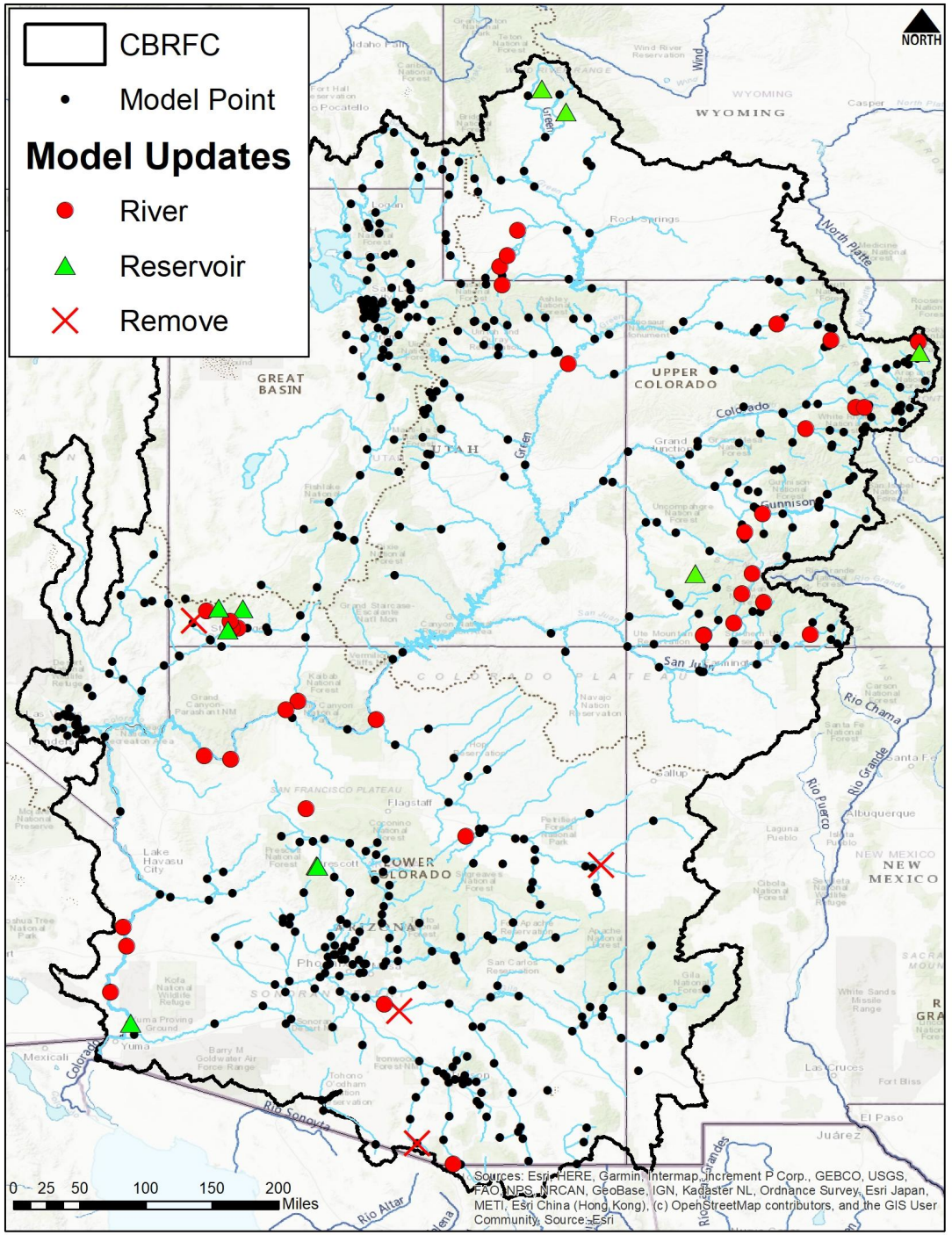
CBRFC Model Basin Updates

Upper Colorado

20 new river points
4 new reservoirs

Lower Colorado

16 new river points
6 new reservoirs
4 river points removed



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
  - Possibly adding new diversion data on the Blacks Fork above Little America
  - Could potentially help Flaming Gorge inflow forecast

Hydrologic Model Adjustments/Considerations/Improvements Global Changes

- Reduce ET above treeline
  - Improve model undersimulation 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/Considerations/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

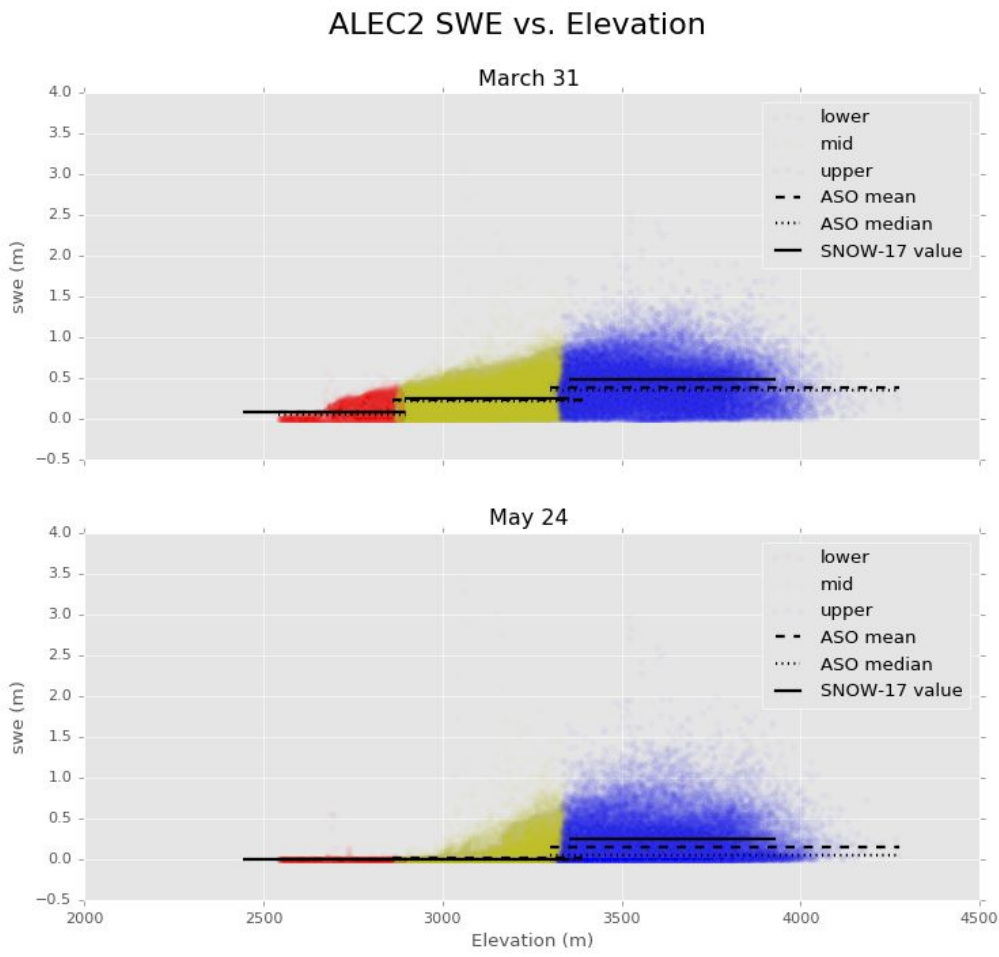
NASA ASO (Airborne Snow Observatory)

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

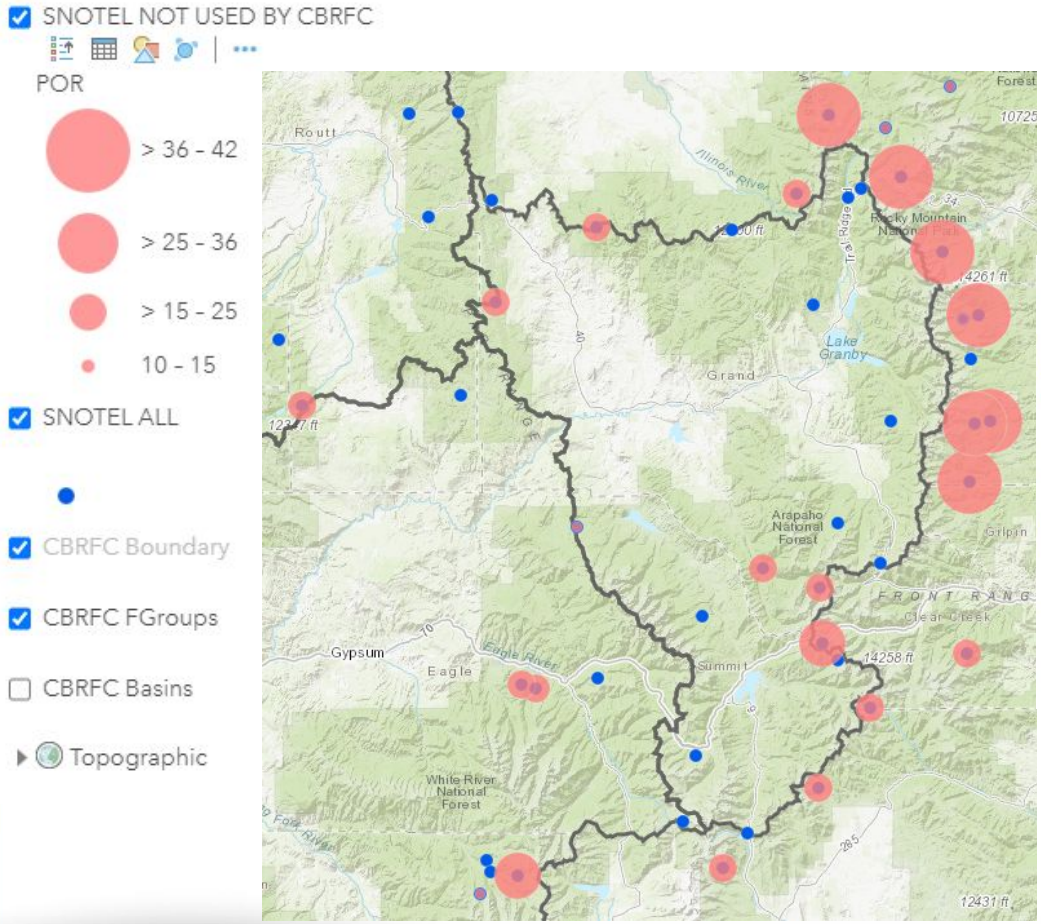
- Preliminary CBRFC ASO findings:
  - ASO estimates less water stored as snow at the highest elevation zones (above 11,000 ft) when compared to SNOW-17 modeled snow
    - Based on analysis using a limited number (3 flights across 4 basins) of ASO flights over the Gunnison River Basin in Colorado
      - 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



SNOTEL Station Period of Record (POR) Analysis



Spatial/gage density analysis

Usability will be determined during calibration QC/trend analysis process

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

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

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