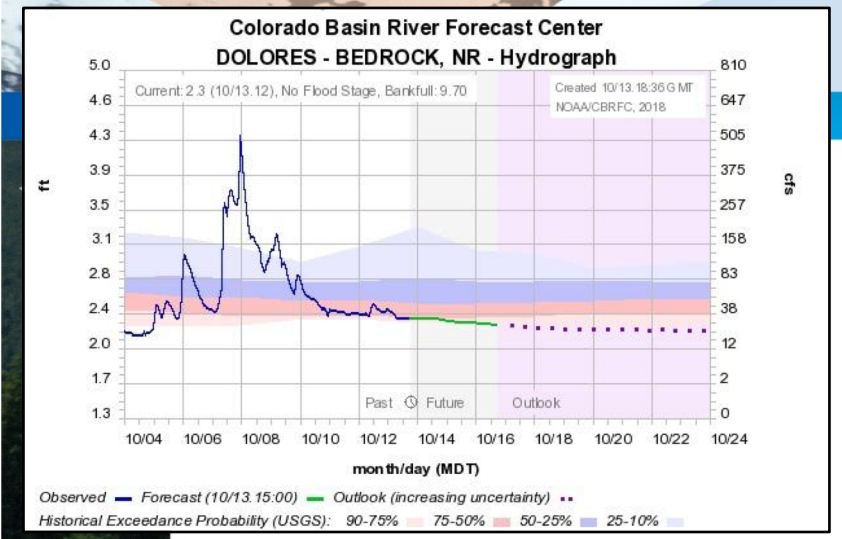
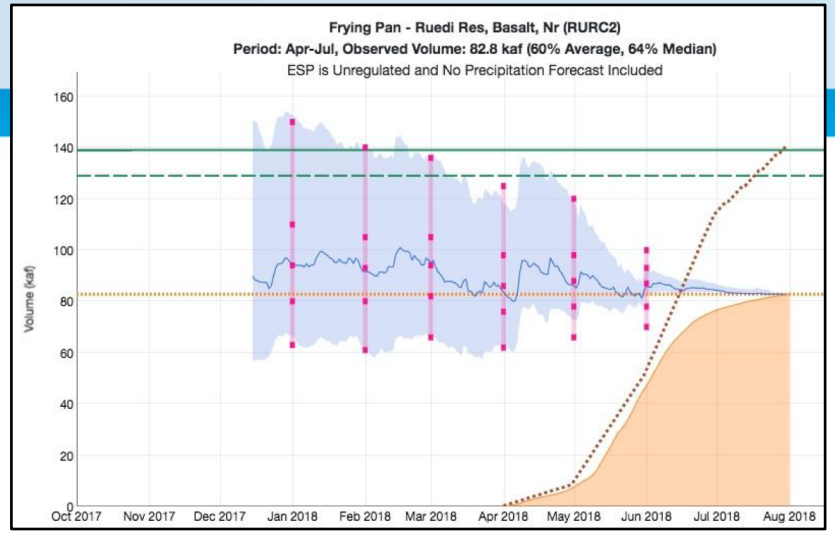
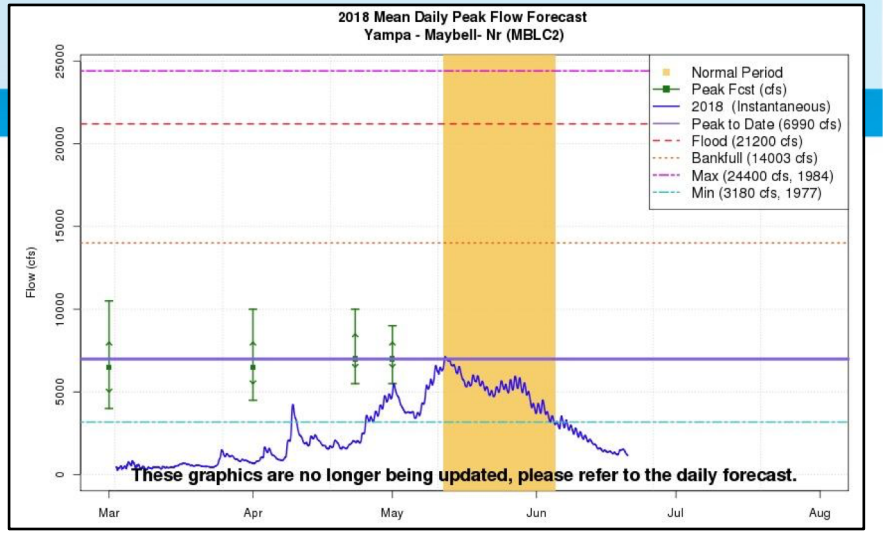
CBRFC Streamflow Forecast Products & Challenges

CBRFC Streamflow Forecast Product Overview (Plots)







10-day Streamflow Forecast

Deterministic

1-hr Streamflow (cfs/stage)

Daily

Regulated

5-day QPF (zero for days 6-10)
10-day QTF

Water Supply Forecast (ESP)

Probabilistic

April - July Volume (kaf)

Monthly (Jan1-Jun1)

Unregulated

5-day or Climo QPF (Climo beyond)
10-day QTF (Climo beyond)

Peak Flow Forecast (ESP)

Probabilistic

Peak Mean Daily Apr-Jul Streamflow (cfs)

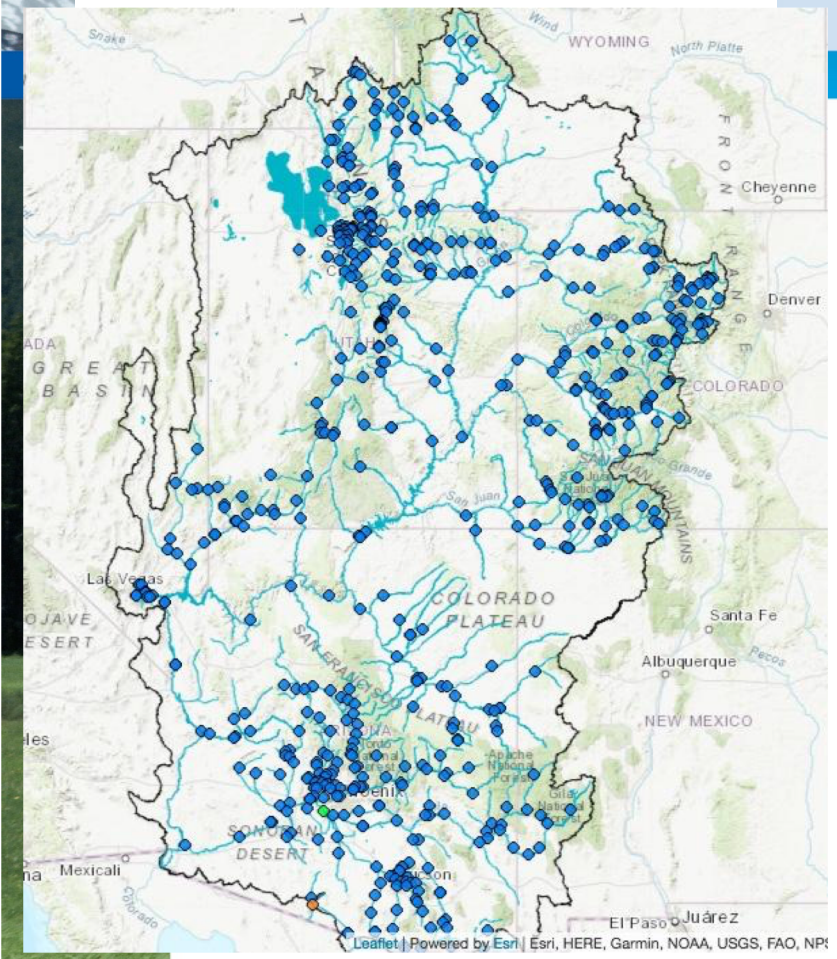
2x / Month (Mar1-May1)

Regulated

5-day or Climo QPF (Climo beyond)
10-day QTF (Climo beyond)

CBRFC Streamflow Forecast Product Overview (Maps)

10-day Streamflow Forecast

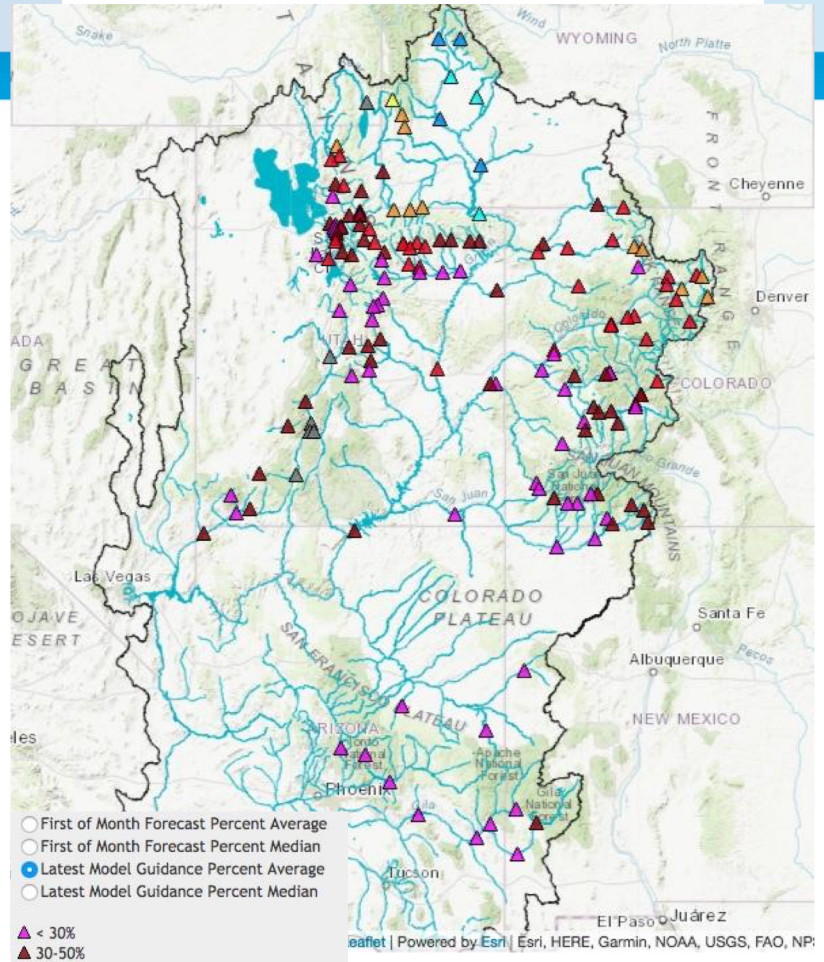


- Not Available
- Normal
- Significant Rise
- Near Bankfull
- Above Bankfull
- Above Flood Stage
- Outlook (> 3 days)

~500 river points
~90 reservoirs

~ 185 with Flood Thresholds

Water Supply Forecast (ESP)



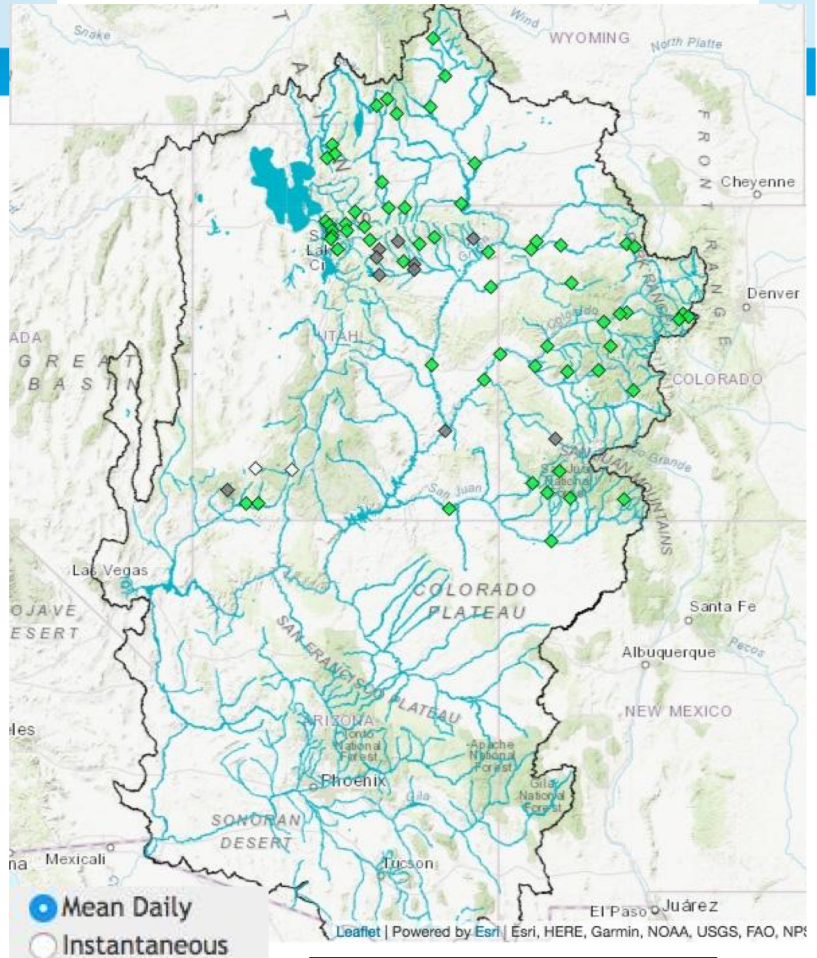
- First of Month Forecast Percent Average
- First of Month Forecast Percent Median
- Latest Model Guidance Percent Average
- Latest Model Guidance Percent Median

- < 30%
- 30-50%
- 50-70%
- 70-90%
- 90-100%
- 100-110%
- 110-130%
- 130-150%
- 150-200%
- 200-300%
- 300-500
- >500%
- Regulated
- No Forecast

~150 points

%Volume
1981-2010

Peak Flow Forecast



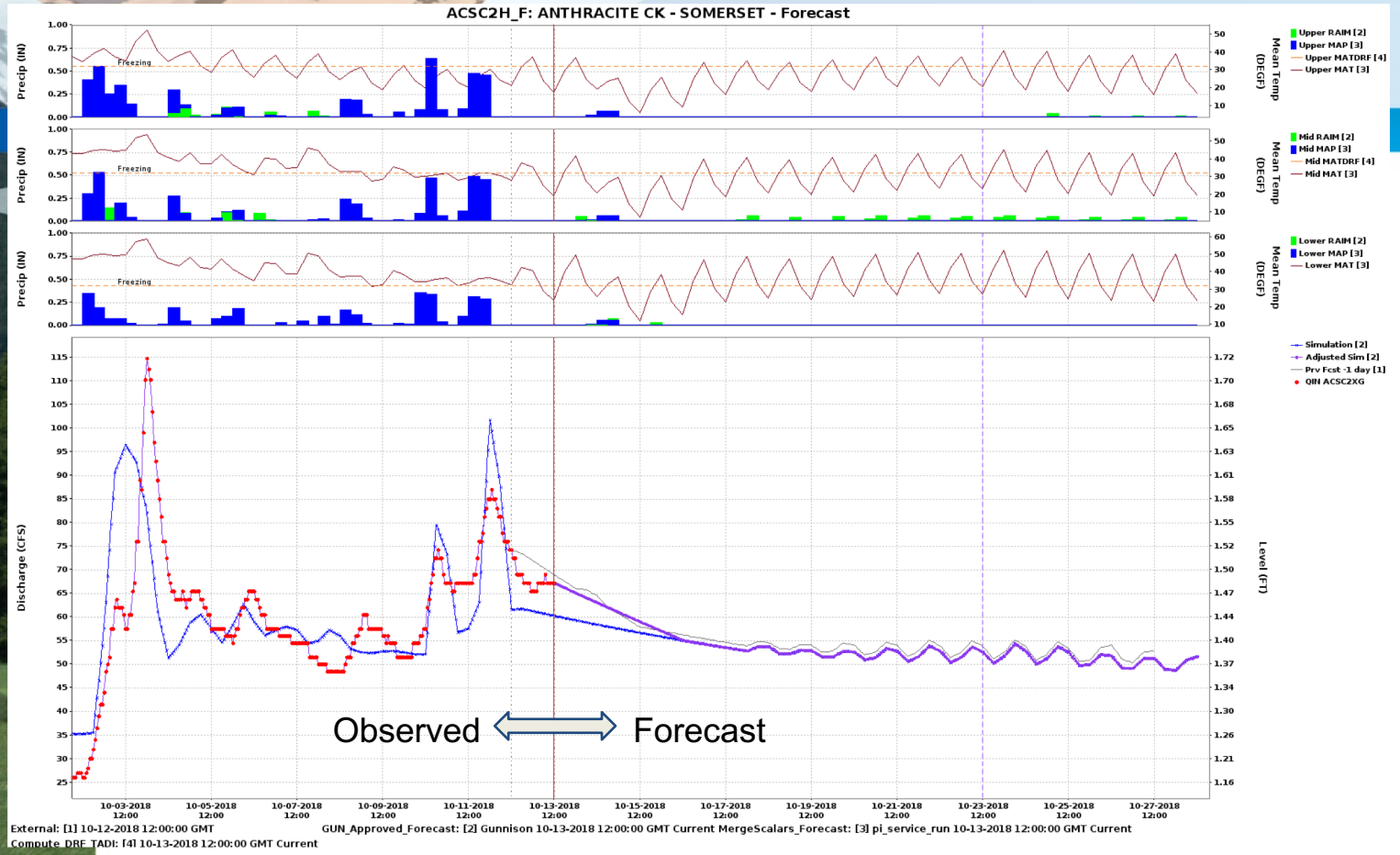
- Mean Daily
- Instantaneous

- No Forecast
- No FLood Stage
- <10%
- >10-25%
- >25-50%
- >50%

~60 points

%Exceeding Flood Threshold

CBRFC 10-day Streamflow Forecasting



- Model States
  - soil moisture
  - snow
- Precipitation Typing
- Assumptions
  - reservoir operations
  - diversions
  - unmeasured depletions
  - irrigation returns

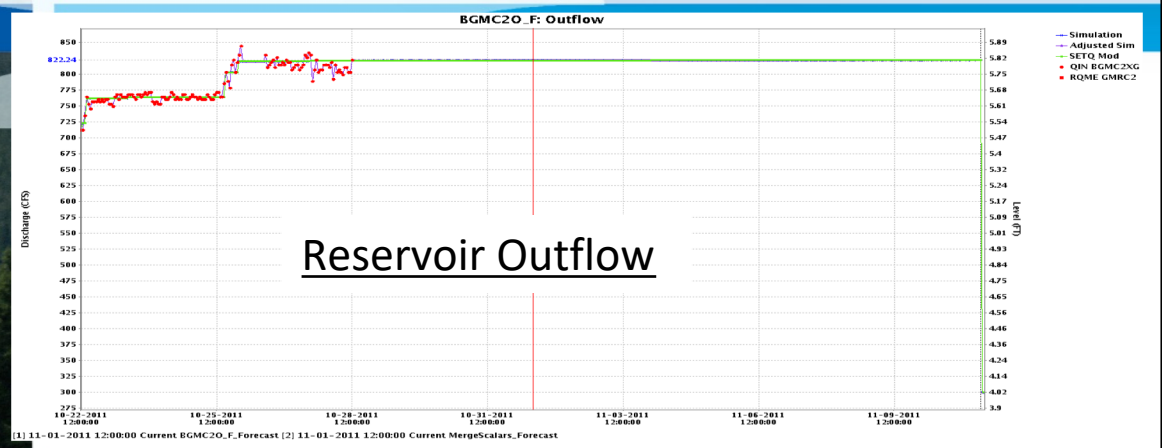
Modifiers

Mod type	Name	Summary	Locations	Start	End	Valid Time	User
TSCHNG Forcings	MAP_ACSC2HLF	MAP ACSC2HLF : Time series	ACSC2HLF	10-10-2018 12:00:00	10-10-2018 12:00:00	10-12-2018 12:00:00	craig.peterson
RAINSNOW	RAINSNOW_ACSC2HLF	RAINSNOW ACSC2HLF : rain	ACSC2HLF	10-02-2018 18:00:00	10-12-2018 12:00:00	--	craig.peterson
CHGBLEND	ADJUSTQ_ACSC2H_F_ADJ_Updat...	72		--	--	--	craig.peterson
RAINSNOW	RAINSNOW_ACSC2HLF	RAINSNOW ACSC2HLF : rain	ACSC2HLF	10-01-2018 18:00:00	10-11-2018 12:00:00	--	craig.peterson
SACCO 6hr	SACCO_6HR_ACSC2HMF	UZTWC ACSC2HMF :	ACSC2HMF	10-01-2018 12:00:00	10-01-2018 12:00:00	--	craig.peterson
SACCO 6hr	SACCO_6HR_ACSC2HUF	UZTWC ACSC2HUF :	ACSC2HUF	10-01-2018 12:00:00	10-01-2018 12:00:00	--	craig.peterson
TSCHNG Forcings	MAP_ACSC2HUF	MAP ACSC2HUF : Time series	ACSC2HUF	10-03-2018 00:00:00	10-03-2018 18:00:00	10-03-2018 12:00:00	brenda.alcorn
TSCHNG Forcings	MAP_ACSC2HMF	MAP ACSC2HMF : Time series	ACSC2HMF	10-03-2018 00:00:00	10-03-2018 18:00:00	10-03-2018 12:00:00	brenda.alcorn

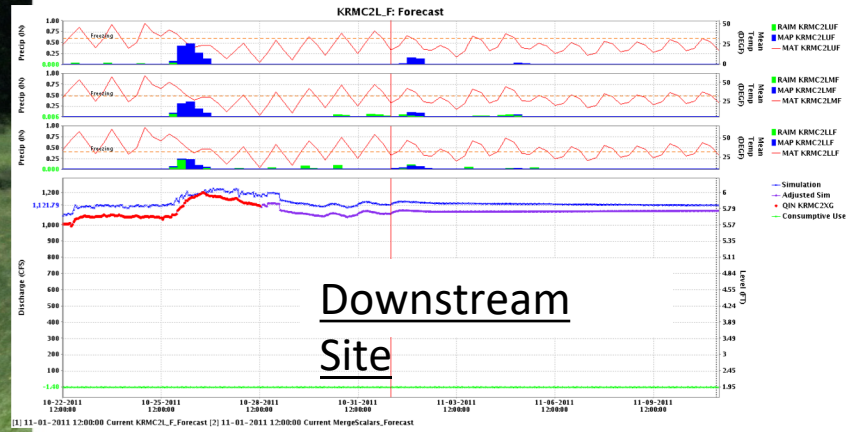
CBRFC Daily Streamflow Forecasting

Reservoir Operations

No Release Schedule

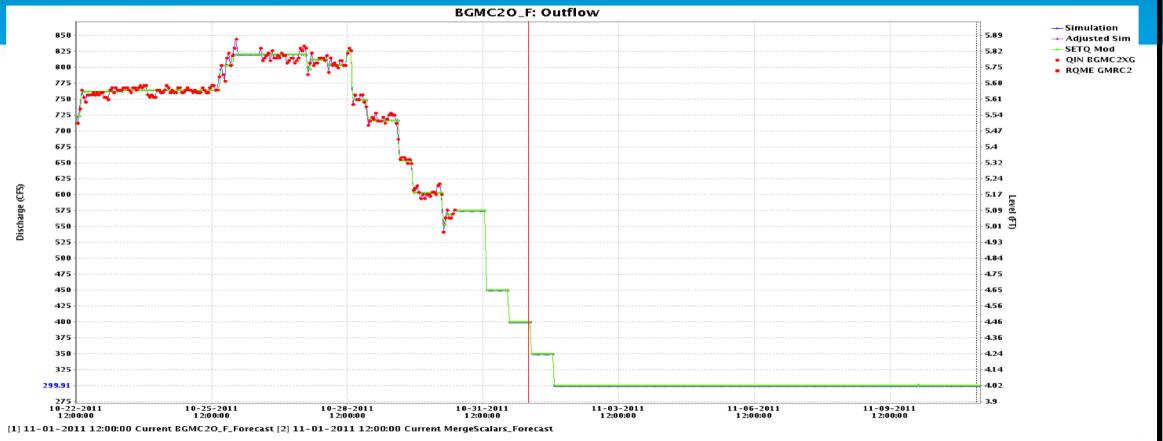


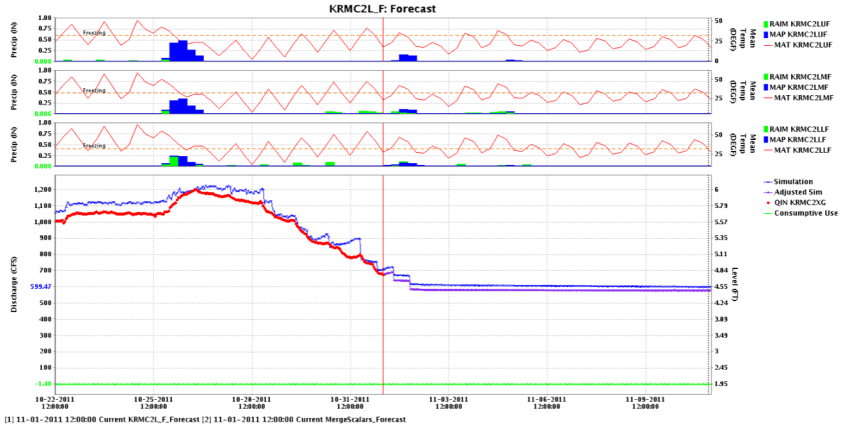
Reservoir Outflow



Downstream Site

Release Schedule





- Releases are held constant at current outflow unless we've been notified of planned changes
- Let reservoir fill & spill? -> try to follow historical patterns and/or reach out to reservoir operators

CBRFC Daily Streamflow Forecasting

Diversions & Unmeasured Depletions

- Unmeasured Depletions & Return Flow
  - Evaluated / estimated during calibration process --> apply CONS-USE model
    - 1981 - 2015 model calibration period
    - Replace CONS-USE model with observed diversion data as it becomes available
      - Return flow uncertainty

- Measured Diversions
  - Provide clear picture of current conditions
  - How much / when will water be diverted at these locations over the next 10 days?
    - Diversions generally held constant at current values; exceptions:
      - We've been notified of a change in the future diversion
      - Known minimum flow requirements / max diversion capacity?
      - Use best guess; understand uncertainty involved
        - Developing historical data relationships to improve estimated future diversions

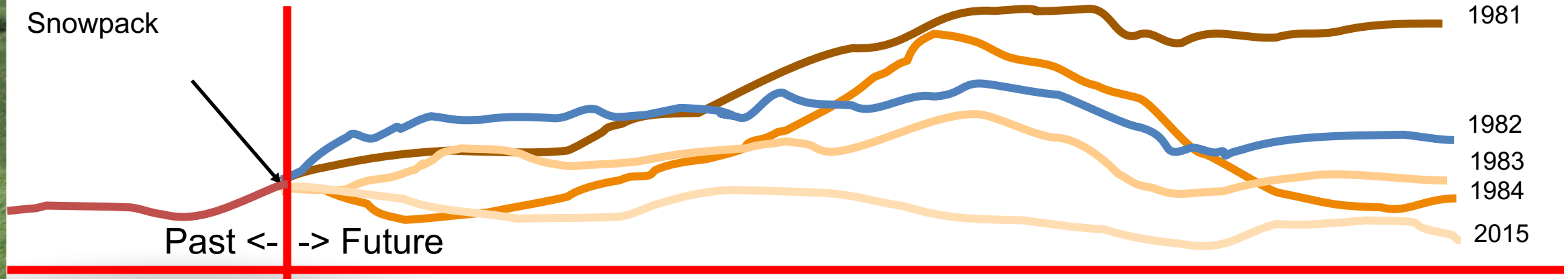
CBRFC Water Supply Forecasting

ESP Overview

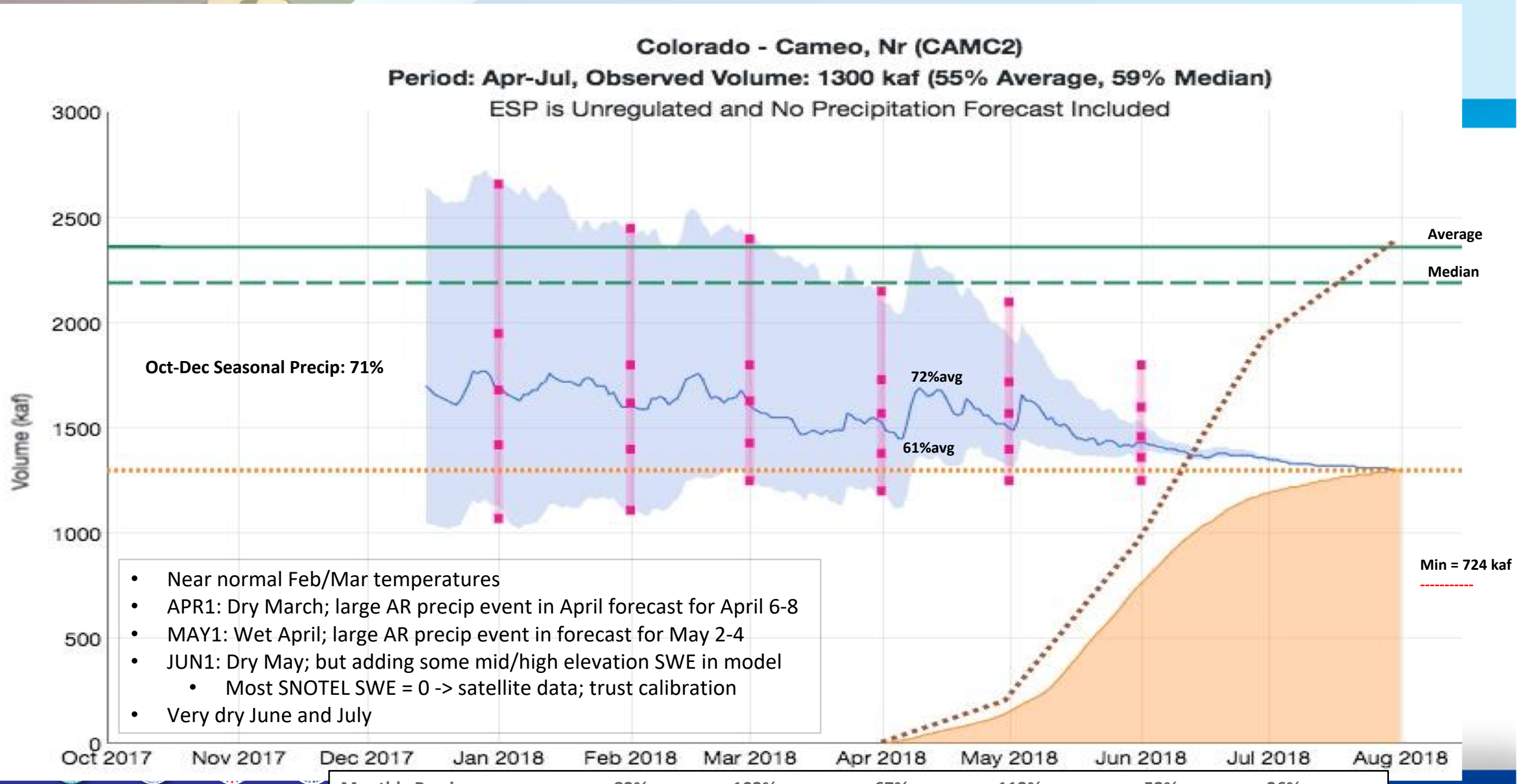
- Start with current conditions of streamflow, soil moisture, snowpack
- Apply precipitation and temperature from each historical year used in model calibration (1981-2015)
- A forecast is generated for each of the years (1981-2015)
  - This creates 35 possible future streamflow patterns
  - Each year is given a 1/35 chance of occurring

Current hydrologic model states:

River / Res. Levels
Soil Moisture
Snowpack



CBRFC Water Supply Forecasting



CBRFC Water Supply Forecasting

- Forecasting unregulated volume
  - reservoirs and diversions do not exist; all water passed downstream
  - CONS-USE operation (for unmeasured depletions) still takes water out of system (this is part of what keeps these 'unreg' forecasts from being 'natural')

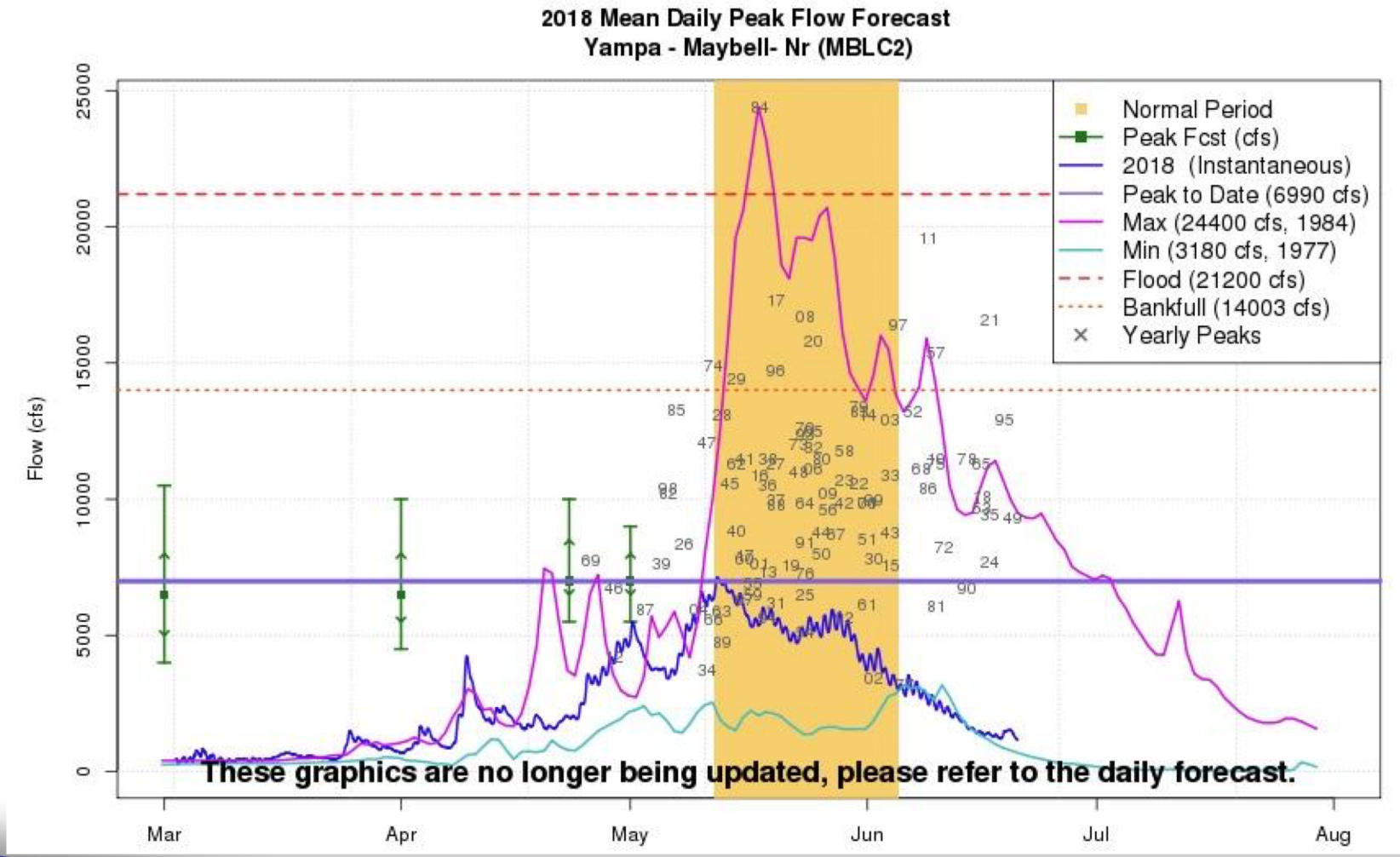
- Verification is a path to improvement, helps us know where to focus efforts; stats available on web page

- Primary sources of error in the forecast:
  - Future weather (largest uncertainty and impact) -> assume climatology beyond 5 days
    - Extreme future weather results in largest forecast errors
  - Data Issues (impact model states such as snowpack)
    - Bad data quality, non-functioning gages, network outages
    - Data availability, network density
  - Model calibration limitations
    - Quality / availability of historical data
    - Unknown / ungaged Diversions
    - Changes in the river basin

CBRFC Peak Flow Forecasting

Plot Options:

-Record Year Data
-Yearly Peaks
-Flood Flow



CBRFC Peak Flow Forecasting

Peak Flow forecasts (from regulated ESP):

- Probabilistic: likelihood of exceeding bankfull / flood thresholds

- Accounts for reservoirs / diversions
  - reservoir releases determined using predefined 'rules' based on either time of year or elevation (allows for spill)
  - diversions: each trace uses the observed diversion from that year

- Do not provide a specific date of the peak forecast
  - provide average time period of the peak

- Instantaneous peak flow forecasts available at locations with strong daily correlation & historical data

- Challenges:
  - timing -> temperature -> rain on snow? -> snowpack elevation -> multiple peaks possible?

CBRFC Peak Flow Forecasting

Proposed Changes

Snowmelt Peak Forecasts

- Current suite of products
- Minimal proposed changes
  - Daily updates at a subset of points
  - Graphic changes to incorporate more frequent updates; more interactive
  - Similar to water supply evolution plots
- Peak Flow Archive updated

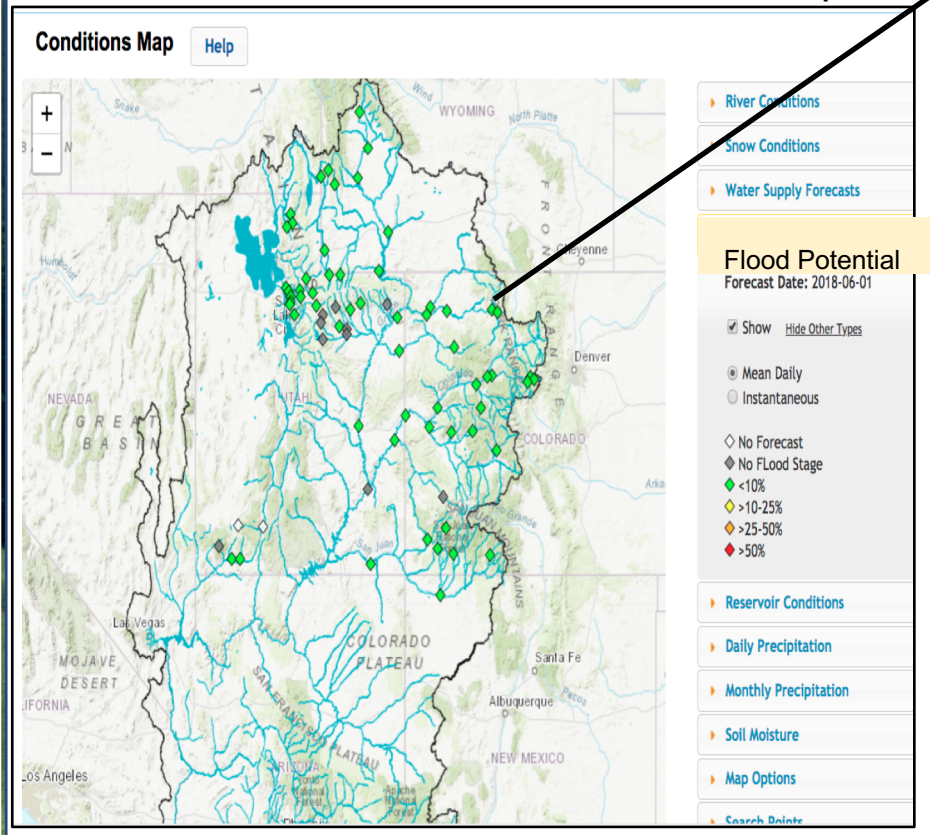
Flood Potential

- New product
- Provide better information and guidance for flooding potential
- Updated daily and throughout entire melt season
- May help with late season challenges associated with long lead peak flow forecasts

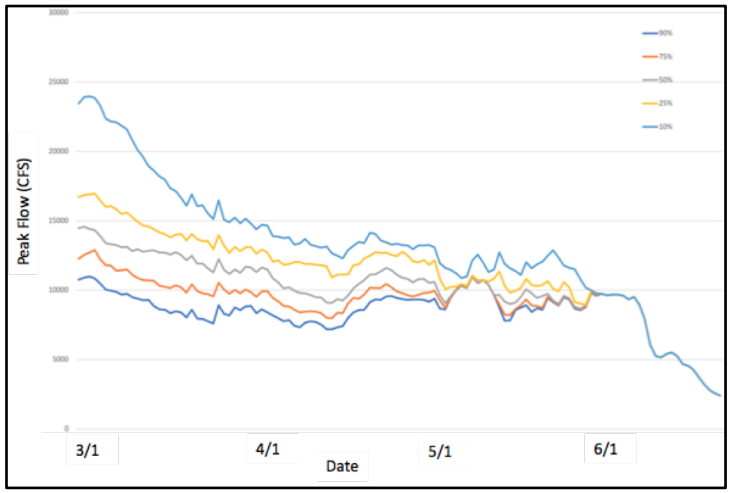
CBRFC Peak Flow Forecasting: Flood Potential "Mock Up"

Selecting a site -> new page with more details

Color Coded Flood Potential Indicator Map



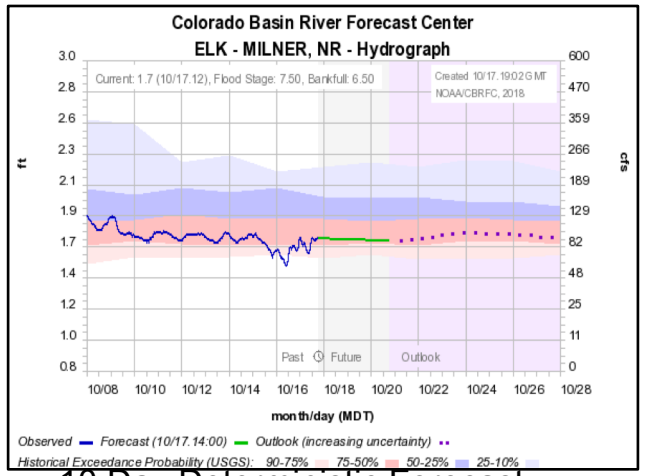
Flood Potential Evolution Plot



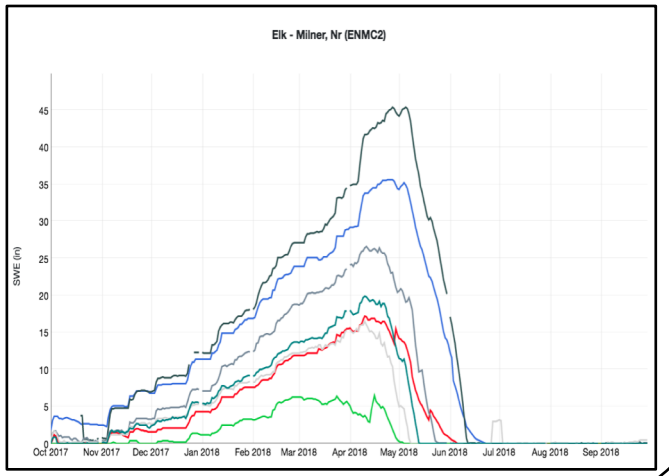
Flood Potential Table

ELK RIVER NEAR MILNER
Forecast Issued: 2019-05-10
Forecast Period: May 10 to July 31
Flood Stage:7.5' Flood Flow: 6220 cfs

Exceedance Probability	Stage (feet)	Discharge (CFS)
90%	6.0	3300
75%	6.5	4000
50%	7.5	6250
25%	8.0	7500
10%	8.5	9000



10 Day Deterministic Forecast

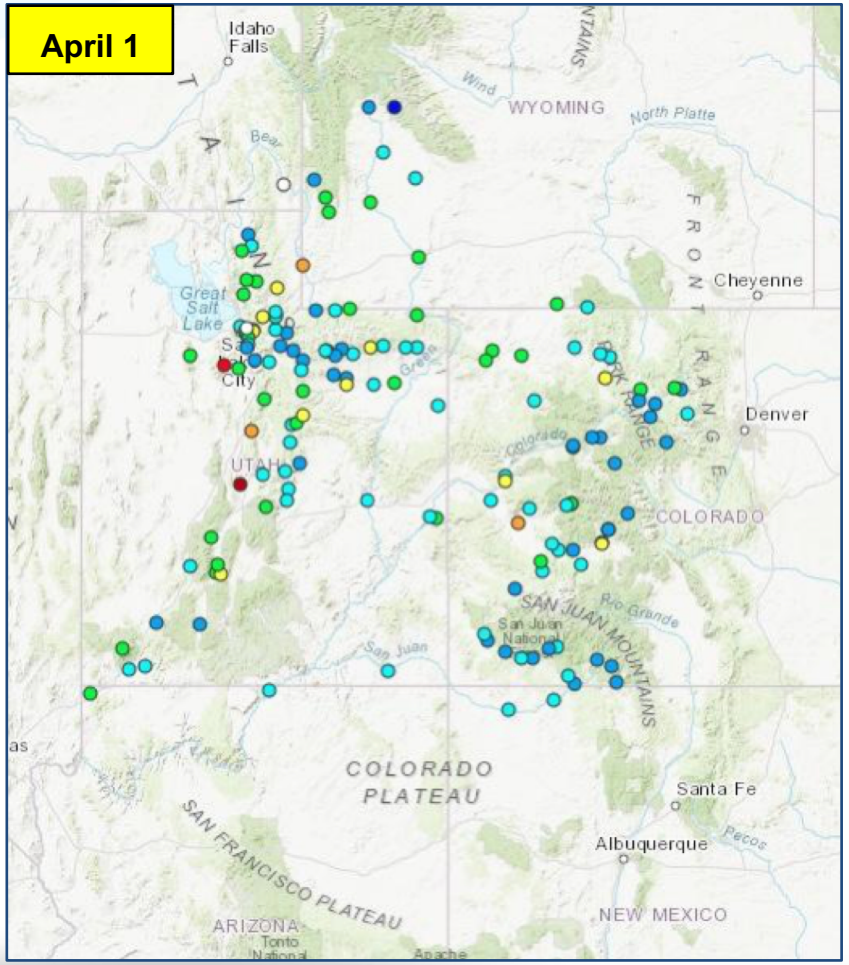


Model Snow

August to October - Verification & Model Improvements

- Verification of forecasts
  - How did we do?
  - Determine sources of error
  - Available on our website
- Model Improvements
  - Address errors identified in verification
  - Incorporate new information
  - Stakeholder requests

Historical Water Supply Verification



Historical Model Error
1981-2010

How good can you expect the forecasts to be

- Available for each month Jan - Jun
- Generally improves through the spring

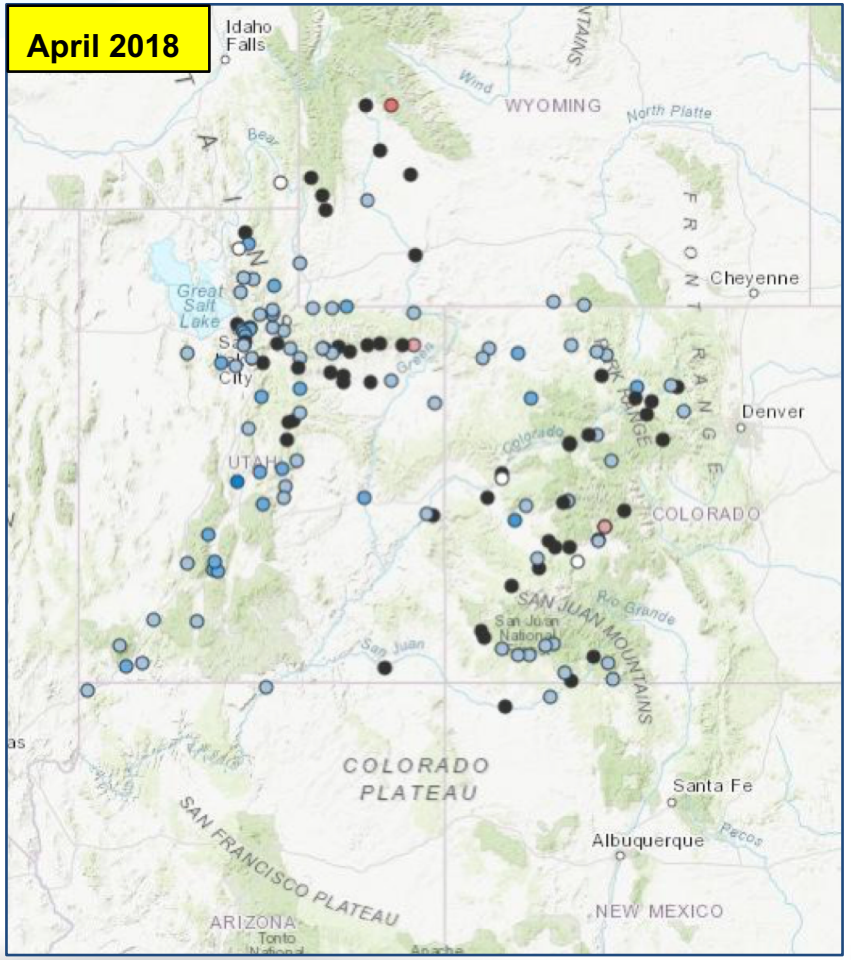
Where we do better:

- Headwaters
- Primarily snow melt basins
- Little/no diversions or historical and real time diversion data available

Where we do worse:

- Lower elevations (rain or early melt)
- Downstream of diversions / irrigation when little is known and/or no data

Yearly Water Supply Verification

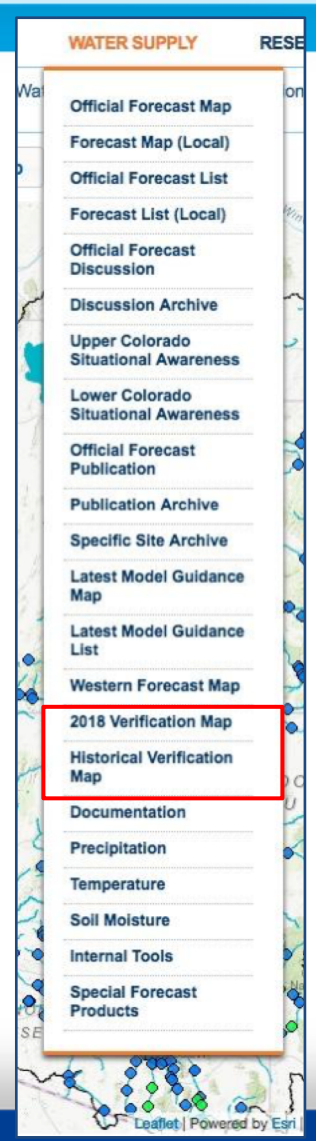


% Error Difference

- No Data
- < -45
- -45 - -35
- -35 - -25
- -25 - -15
- -15 - -5
- -5 - 5
- 5 - 15
- 15 - 25
- 25 - 35
- >35

- Red: %error greater than historical
- Blue: %error less than historical
- Black: %error similar to historical

April 2018 forecasts were generally more accurate than historical April forecasts



Questions
&
Quick Web Tour