Forecast Challenges for the Colorado Basin River Forecast Center

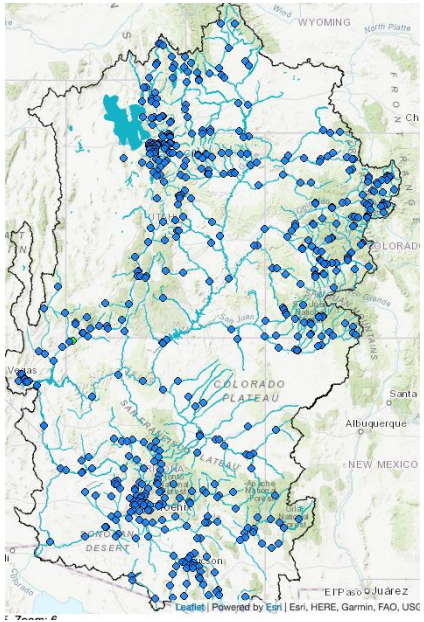
John Lhotak, Development and Operations Hydrologist

Improving Sub-Seasonal to Seasonal (S2S) Workshop

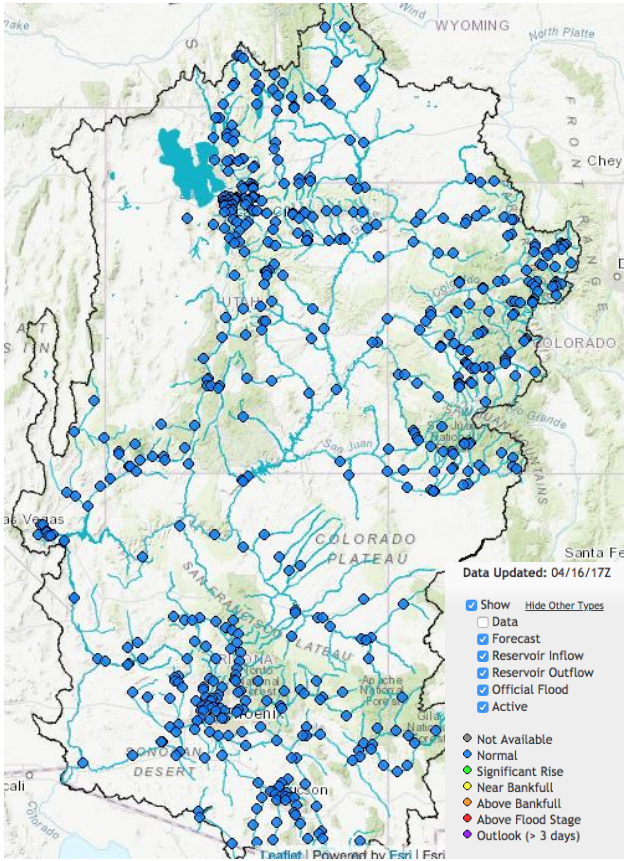
May 16th, 2018

National Weather Service River Forecast Centers

- Provide streamflow forecasts for the next few hours to seasons
- 10 day forecasts for flood warnings, recreational use, etc..
- Develop probabilistic forecast of volume of water expected during the snow melt season for reservoir operations and planning - Water Supply Forecasts



Streamflow forecasts - Routine & Flood

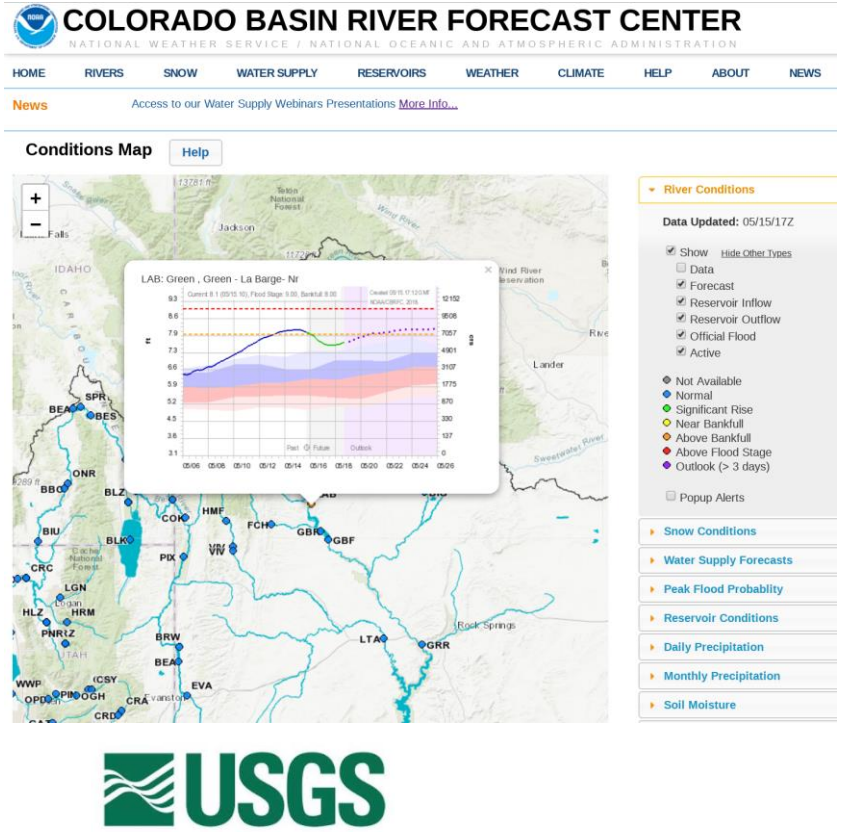


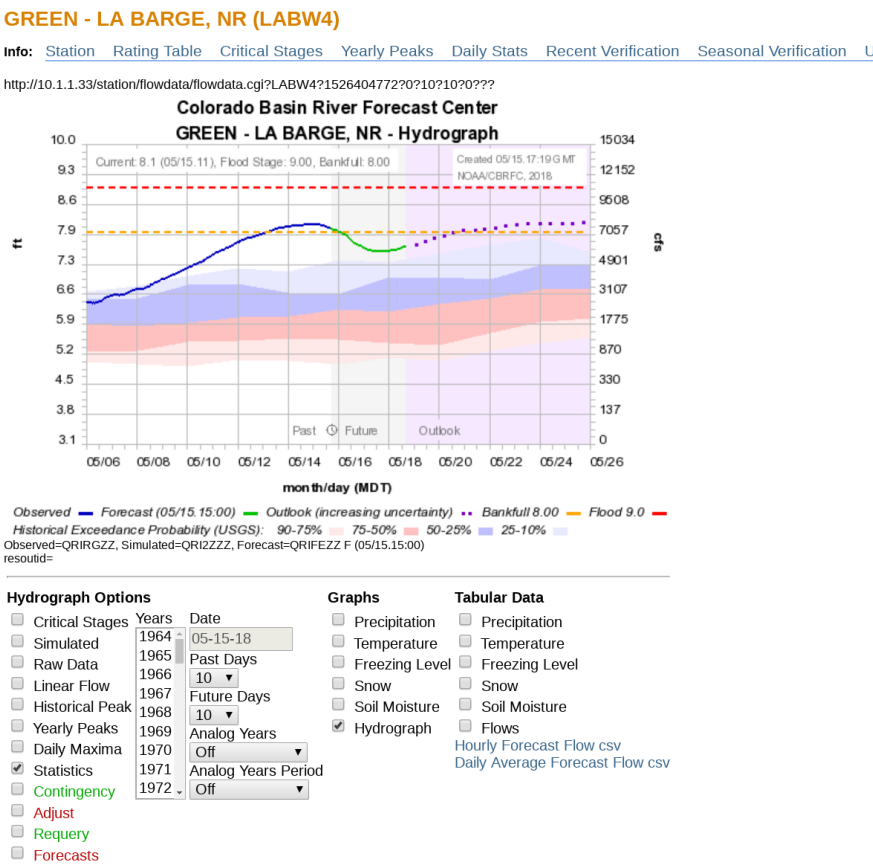
River Point Condition
NA Normal Rise Near Bankfull Bankfull Flood Stage Trend (> 3 days)

River Point Types
0-Data 1-Forecast 2-Reservoir

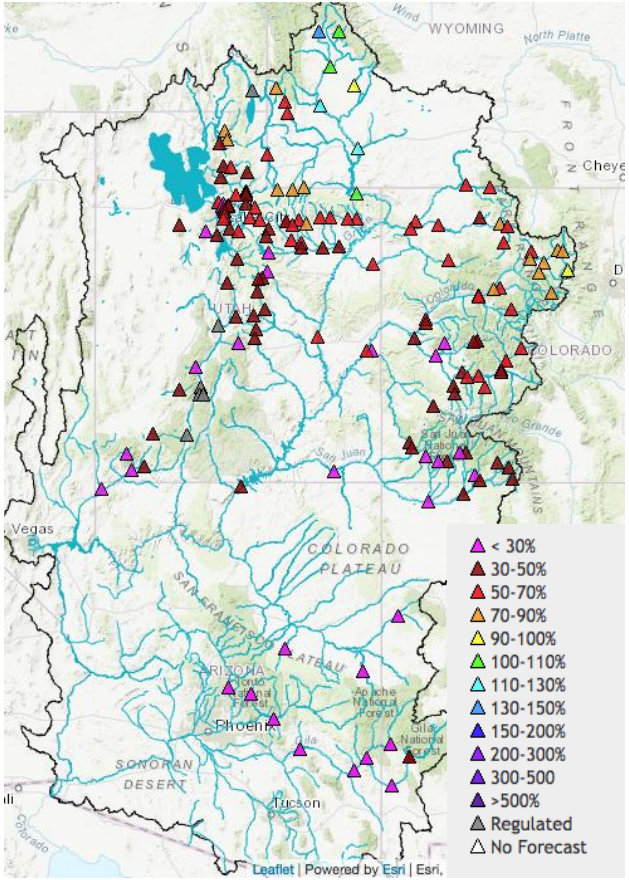
	NWS ID	River	Location	Forecast Condition	Point Type	Observed Date (Day, Time)	Latest Flow	Latest Stage	Flood Stage	Bankfull Stage	HUC	State	HSA	Elevation	Forecast Group	Segment
1	LABW4	Green	La Barge, Nr		1	16, 12:00	6476	7.8	9	8	14040101	WY	RIW	6520	GREEN	4
2	MAOA3	Acdc	14th Street		1	16, 07:00	0	0.4		10	15060106	AZ	PSR	1230	AGUAFRIA	6
3	MHFA3	Acdc	43rd Avenue		1	16, 07:00	0	0.9		4	15060106	AZ	PSR	1225	AGUAFRIA	7
4	MSXA3	Acdc	67th Ave		1	16, 07:00				6	15070102	AZ	PSR	1220	AGUAFRIA	8
5	ACHA3	Agua Caliente Wash	Houghton Rd		1	15, 22:00	0	0.8		4.9	15050302	AZ	TWC	2588	SANTACRZ	2
6	AFHA3	Agua Fria	Humboldt, Nr		1	16, 12:00	0	0.74		15.5	15070102	AZ	FGZ	4400	AGUAFRIA	17
7	AFMA3	Agua Fria	Mayer, Nr		1	16, 11:00	0	2		15.1	15070102	AZ	FGZ	3434	AGUAFRIA	18
8	AFRA3	Agua Fria	Rock Spgs, Nr		1	16, 11:00	0	2.5	16	15	15070102	AZ	PSR	1800	AGUAFRIA	19
9	AVOA3	Agua Fria	Buckeye		1	16, 07:00	0	1.3		8	15070102	AZ	PSR	970	AGUAFRIA	26
10	MAFA3	Agua Fria	Grand Ave		1	16, 07:00	0	1.8		14	15070102	AZ	PSR	1115	AGUAFRIA	24
11	ATPA3	Altar Wash	Three Points, Nr		1	16, 08:00	0	1.4		14	15050304	AZ	TWC	2975	SANTACRZ	24
12	AFPU1	American Fork	American Fork, Nr, Up Pwrplnt, Abv		1	16, 11:00	49	6.4	8.5	8.2	16020201	UT	SLC	5950	PROVO	11
13	ARFN5	Animas	Farmington		1	16, 11:00	851	5.5	10	9	14080104	NM	ABQ	5280	SANJUAN	18
14	CDRC2	Animas	Cedar Hill, Nr		1	16, 12:00	913	6.4	10.5	9.5	14080104	CO	ABQ	5960	SANJUAN	17
15	DGOC2	Animas	Durango Pump Plant, Blo		1	16, 12:00	1270	4.6			14080104	CO	GJT	6437	SANJUAN	13
16	DRGC2	Animas	Durango		1	16, 11:00	1250	3.6	8	7	14080104	CO	GJT	6502	SANJUAN	12
17	ACSC2	Anthracite Ck	Mouth, Abv, Somerset, Nr		1	16, 11:00	789	3			14020004	CO	GJT	6280	GUN	24
18	ARVA3	Aravaipa Ck	Mammoth		1	16, 12:00	2	0.28	12.8	10.8	15050203	AZ	TWC	2345	SANPEDRO	8
19	AVCA3	Arivaca Ck	Arivaca		1					4	15050304	AZ	TWC	3580	SANTACRZ	23
20	ACJU1	Ashley Ck	Jensen, Nr, Union Canal, Blo		1	15, 12:00	0			10.2	14060002	UT	GJT	4740	DUCHPR	4
441	SHOA3	Show Low Lake	Show Low, Nr		1						15020005	AZ	FGZ	6580	LITCOL	9
442	SSFA3	Silver Ck	Snowflake, Abv		1						15020005	AZ	FGZ	0	LITCOL	12
443	SFRU1	South Fork Rock Ck	Docs Div, Blo		1	16, 11:00	8				14060003	UT	SLC	8201	DUCHPR	15
444	UERU1	Upper Enterprise Reservoir			1						16030006	UT	SLC	5691	SEV_H	15
445	RKUU1	Weber	Rockport Res, Wanship, Nr		1		e128				16020101	UT	SLC	6037	WEBER	2

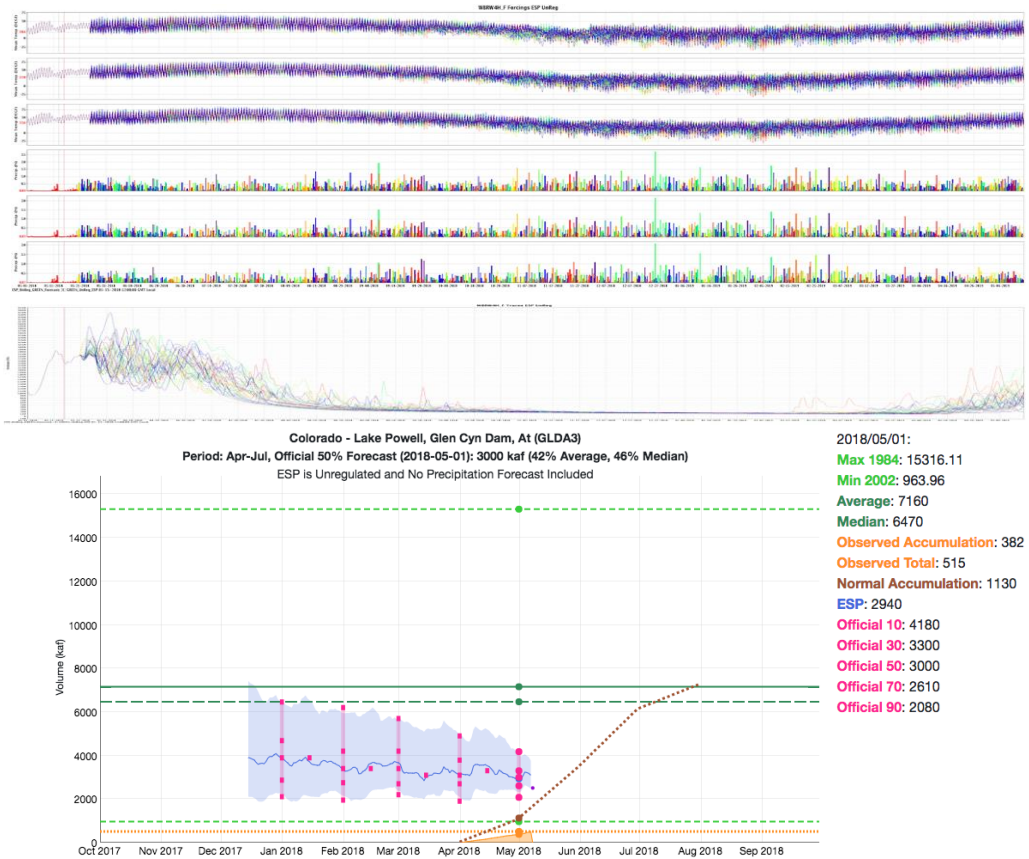
Streamflow forecasts - Hydrographs





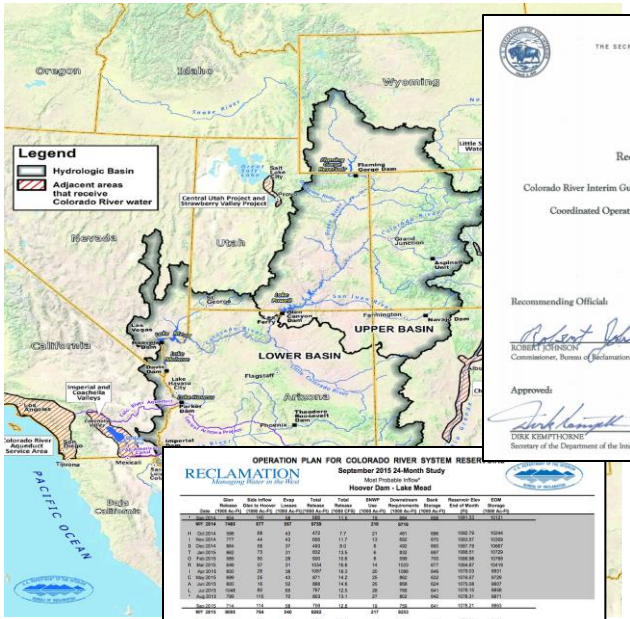
Water Supply Forecasts

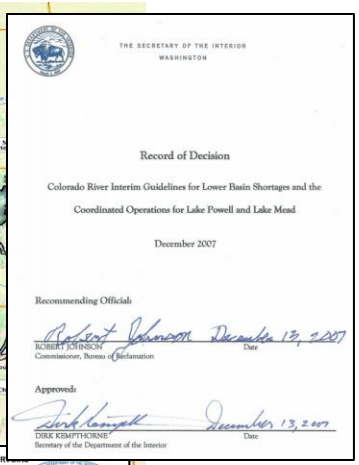




CBRFC Role in Colorado River Management

- CBRFC's water supply forecasts drive Reclamation's operational planning model (24-Month Study)
  - Determine operations of Lakes Powell and Mead
  - Determine shortage declarations
  - Direct impact to State, municipal, agricultural, water and energy managers and Mexico





THE SECRETARY OF THE INTERIOR
WASHINGTON

Record of Decision

Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead

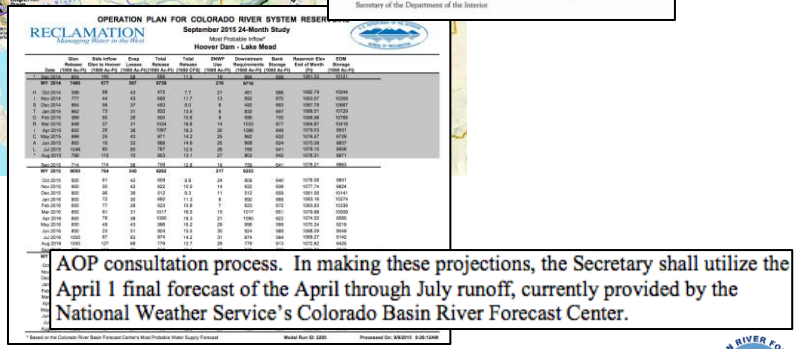
December 2007

Recommending Official:

ROBERT JOHNSON
Commissioner, Bureau of Reclamation
Date

Approved:

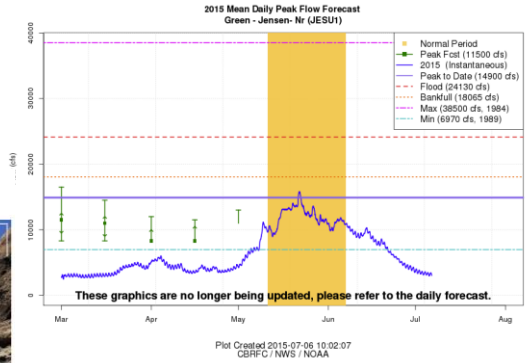
DIRK KEMPTHORNE
Secretary of the Department of the Interior
Date



OPERATION PLAN FOR COLORADO RIVER SYSTEM RESERVOIRS
RECLAMATION
Managing Water in the West
September 2015 24-Month Study
Most Probable Inflow
Hoover Dam - Lake Mead

AOP consultation process. In making these projections, the Secretary shall utilize the April 1 final forecast of the April through July runoff, currently provided by the National Weather Service's Colorado Basin River Forecast Center.

Providing Decision Support Services




May showers bring better outlook for Colorado River, but no miracle

A group of kayakers prepare to head down river while paddling the Black Canyon Water Trail on the lower Colorado River in Lake Mead National Recreation Area on the Nevada and Arizona border east of Las Vegas on Thursday, July 3, 2014. There are 16 routes within the National Water Trail system, and the Black Canyon Water Trail is the first water trail in the Southwest and the only water trail that traverses through a desert. (Jason Bean/Las Vegas Review-Journal)

By HENRY BREAN
LAS VEGAS REVIEW-JOURNAL

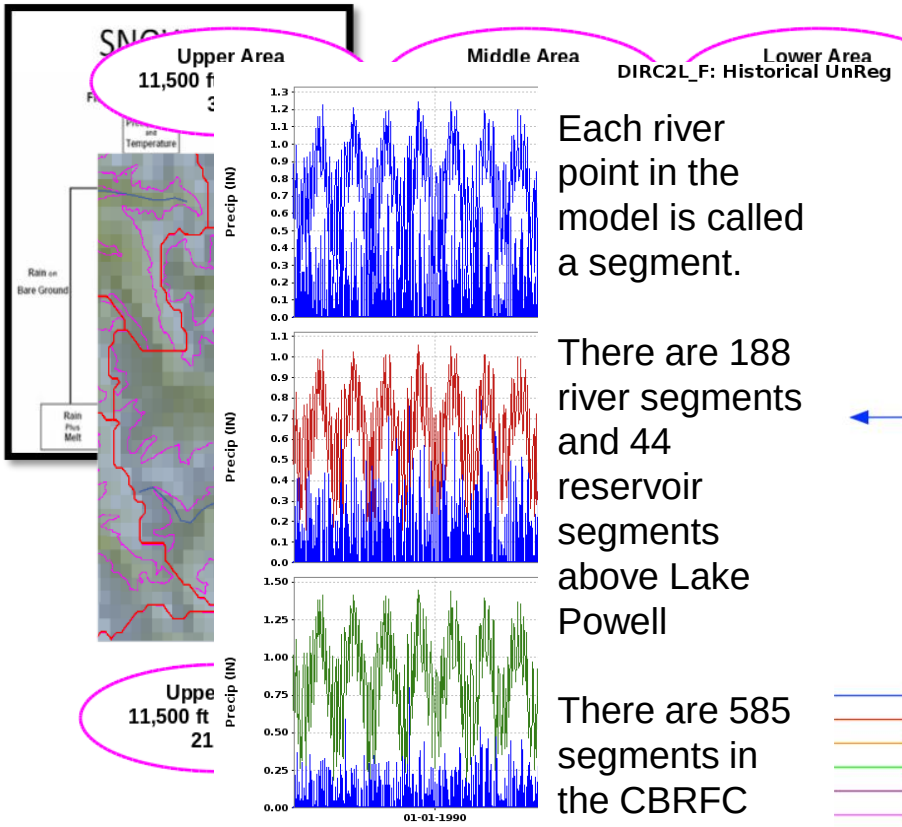
It wasn't the "Miracle May" that some observers called it, but a month of downpours in Colorado and Utah did provide a significant boost to the outlook for the Colorado River.

A terrible year became merely below average.

"'Miracle' is probably a bit of an overstatement, but the unusually wet May did have a positive impact on water supply," said Paul Miller, a senior hydrologist with the National Weather Service's Colorado Basin River Forecast Center in Salt Lake City.

- Resource Management
  - Adaptive Management Program (Peak Flow Forecasts)
  - Day to day decisions, especially during times of active weather
- Technical Support and Communication
  - Meeting participation
  - Custom products and outreach

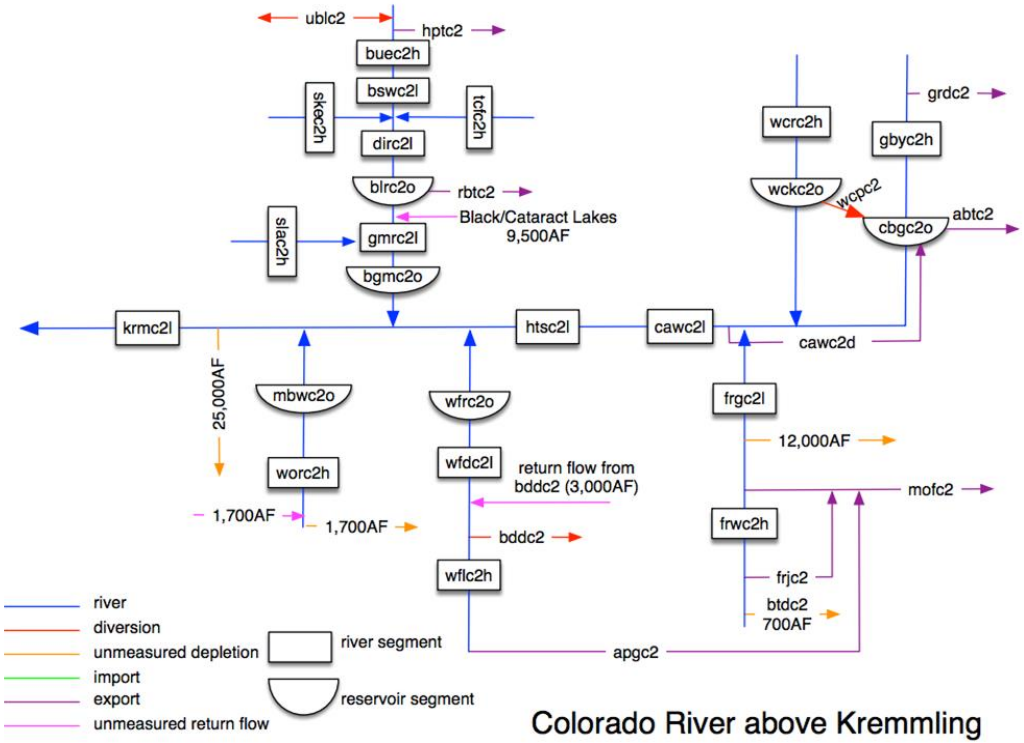
Developing a model



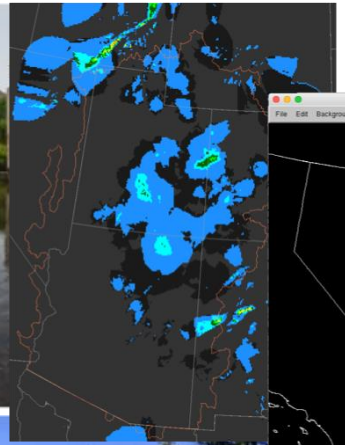
Each river point in the model is called a segment.

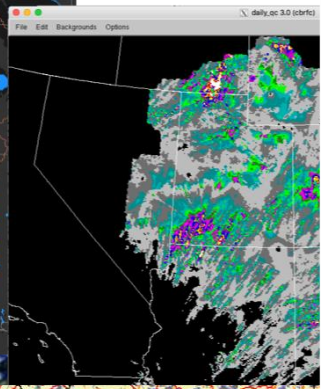
There are 188 river segments and 44 reservoir segments above Lake Powell

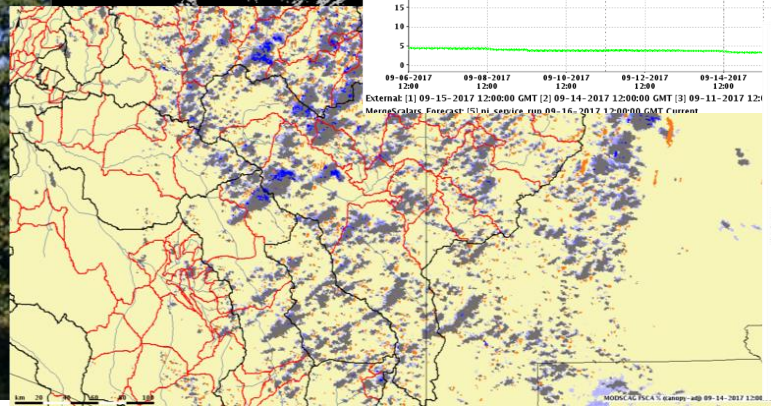
There are 585 segments in the CBRFC area.

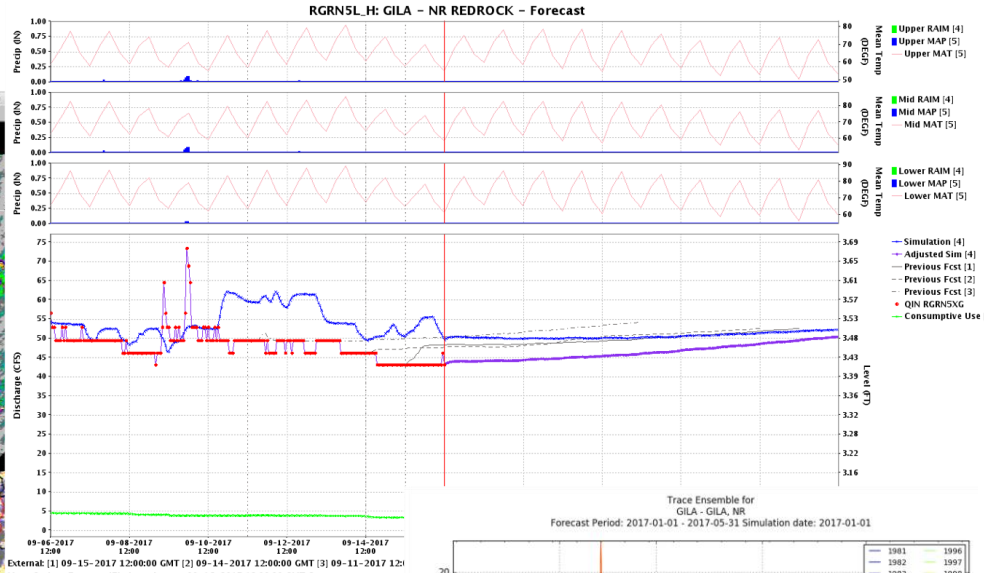


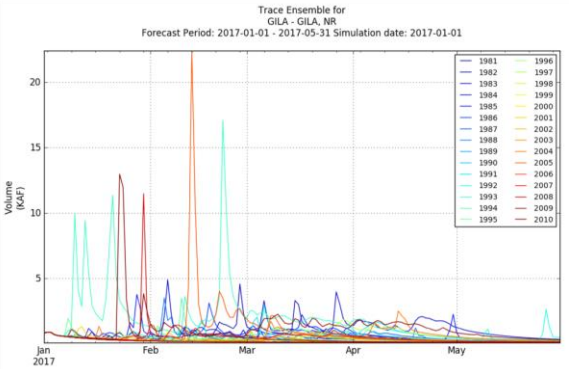
Data and creating a forecast





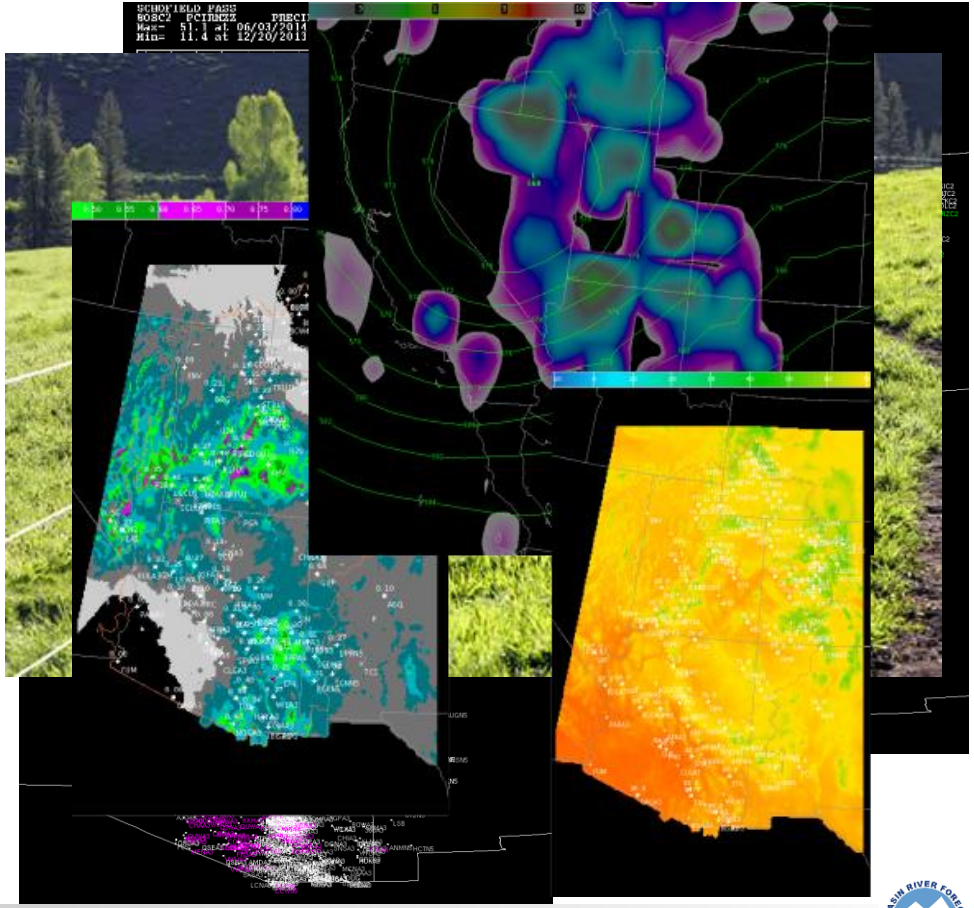






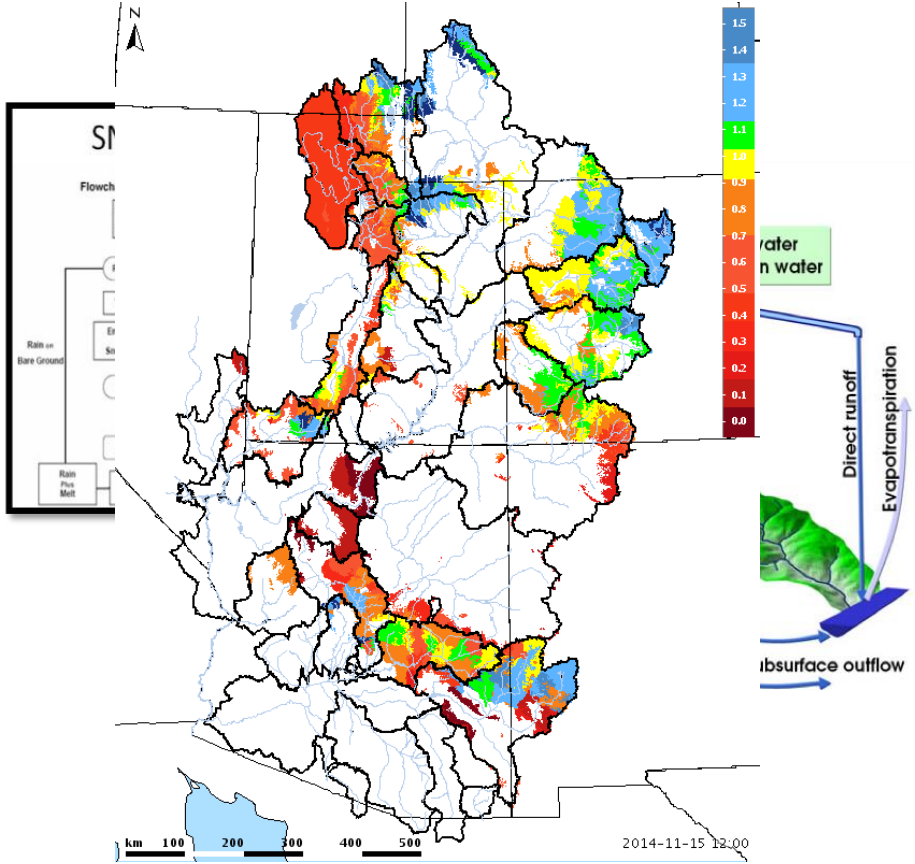
What Affects Forecast Quality - Data

- Undetected errors in historical/current observations
- Data density/Gage network distribution
  - SNOTEL Network
    - Since it became available, has improved accuracy of forecasts
    - In some areas the gage density is better
- Unmeasured Depletions
- Forecasted Weather Conditions



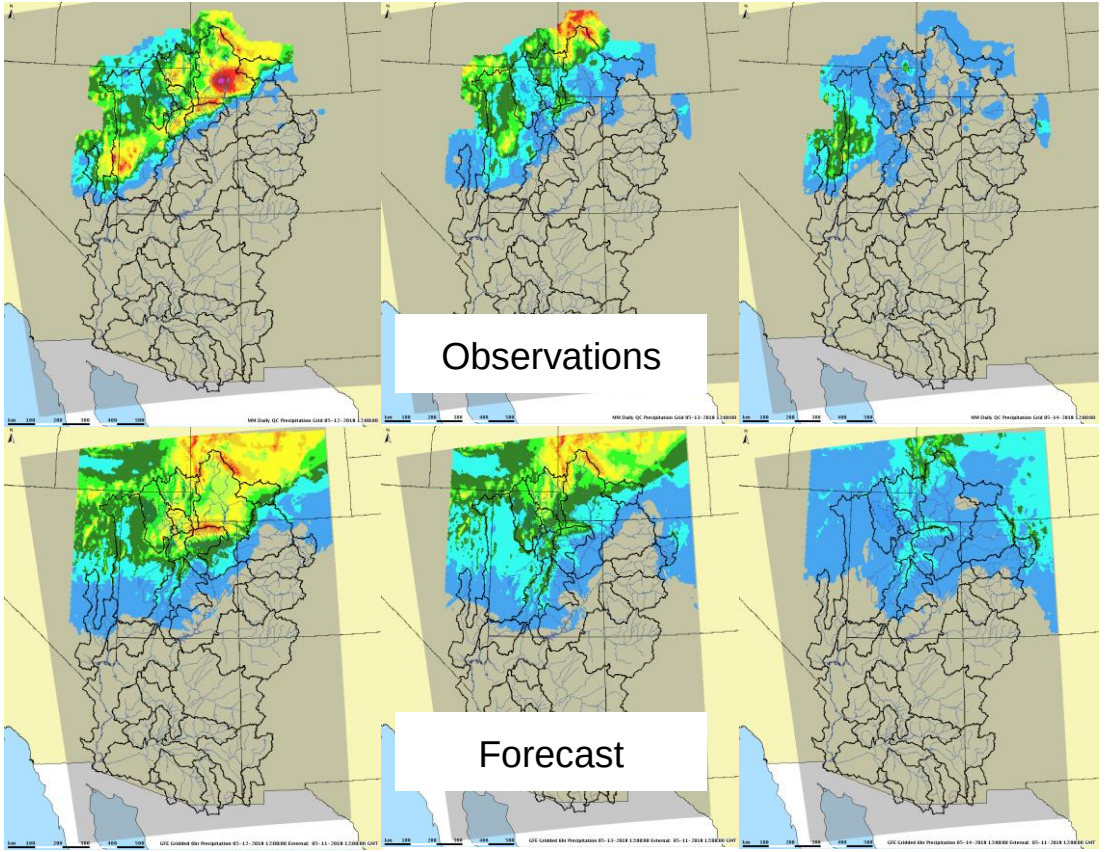
What Affects Forecast Quality - Model

- The model itself
  - Calibration Error (bias)
  - Initial Conditions - Seasonal volumes are controlled by SWE and soil moisture
    - Do we have SWE right?
    - Mischaracterizing rain vs. snow events
    - Missed precipitation event
    - Do we have the soil moisture right?
    - Have we captured baseflow conditions accurately?
    - Has a storm event impacted soil state conditions?



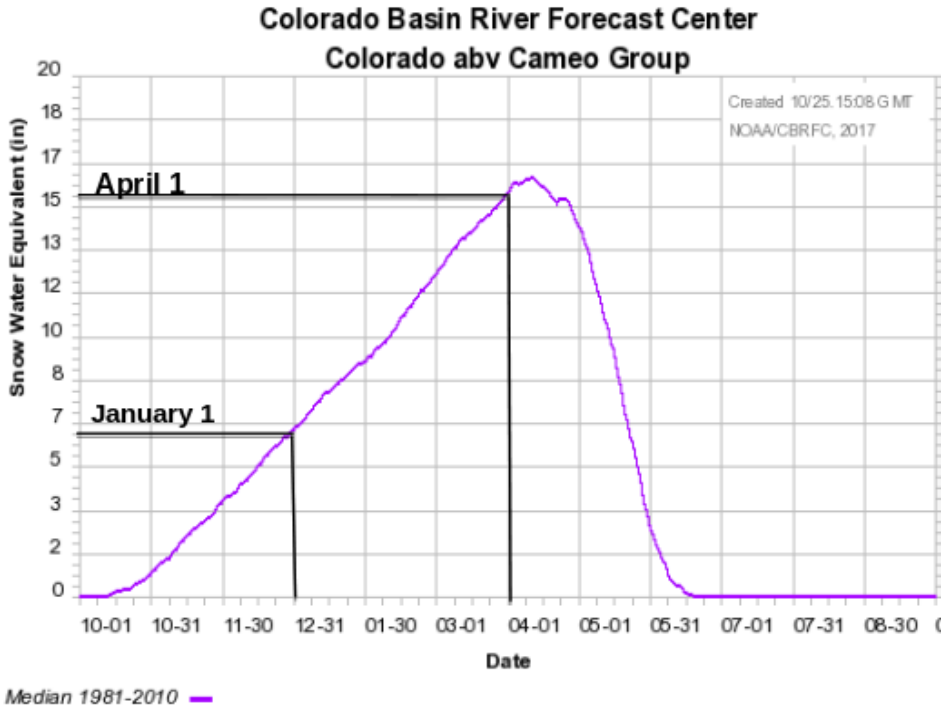
What Affects Forecast Quality - Weather Forecast

- Uncertainty in short term weather
  - Precipitation
    - accuracy
    - distribution in space & time
  - Spring temperatures affect melt/runoff pattern
  - Extreme weather events

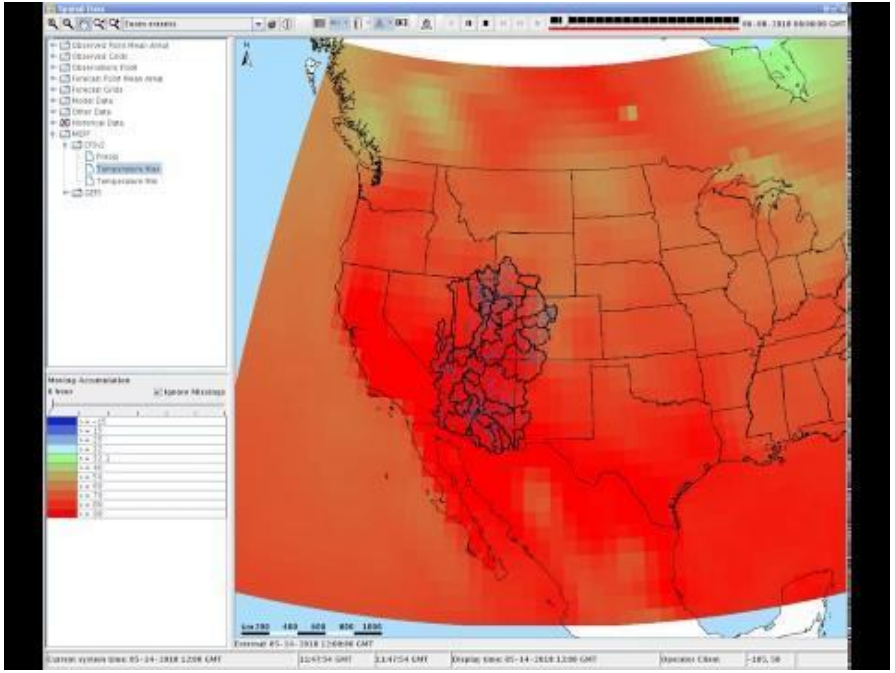


What Affects Forecast Quality - Seasonal Forecast

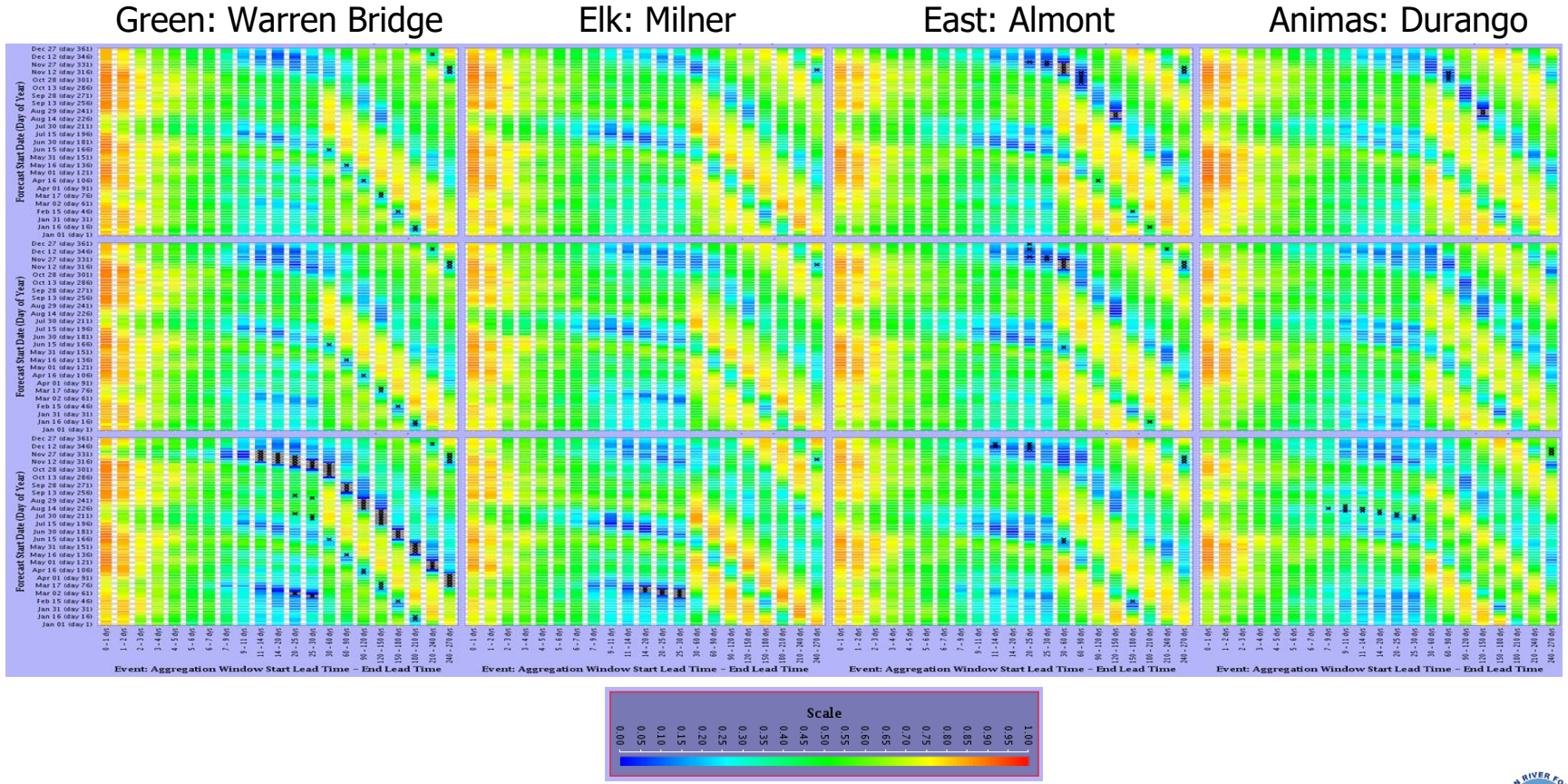
- January 1st Forecast -
  - What we know:
    - ~40% of snowpack accumulation
  - What we DON'T know:
    - Jan-May weather (4 months)
    - ~60% of snowpack accumulation
- April 1st Forecast
  - What we KNOW:
    - ~96% of snowpack accumulation
    - Dec-March weather
  - What we DON'T know:
    - April-May weather (2 months)
    - Snowmelt pattern



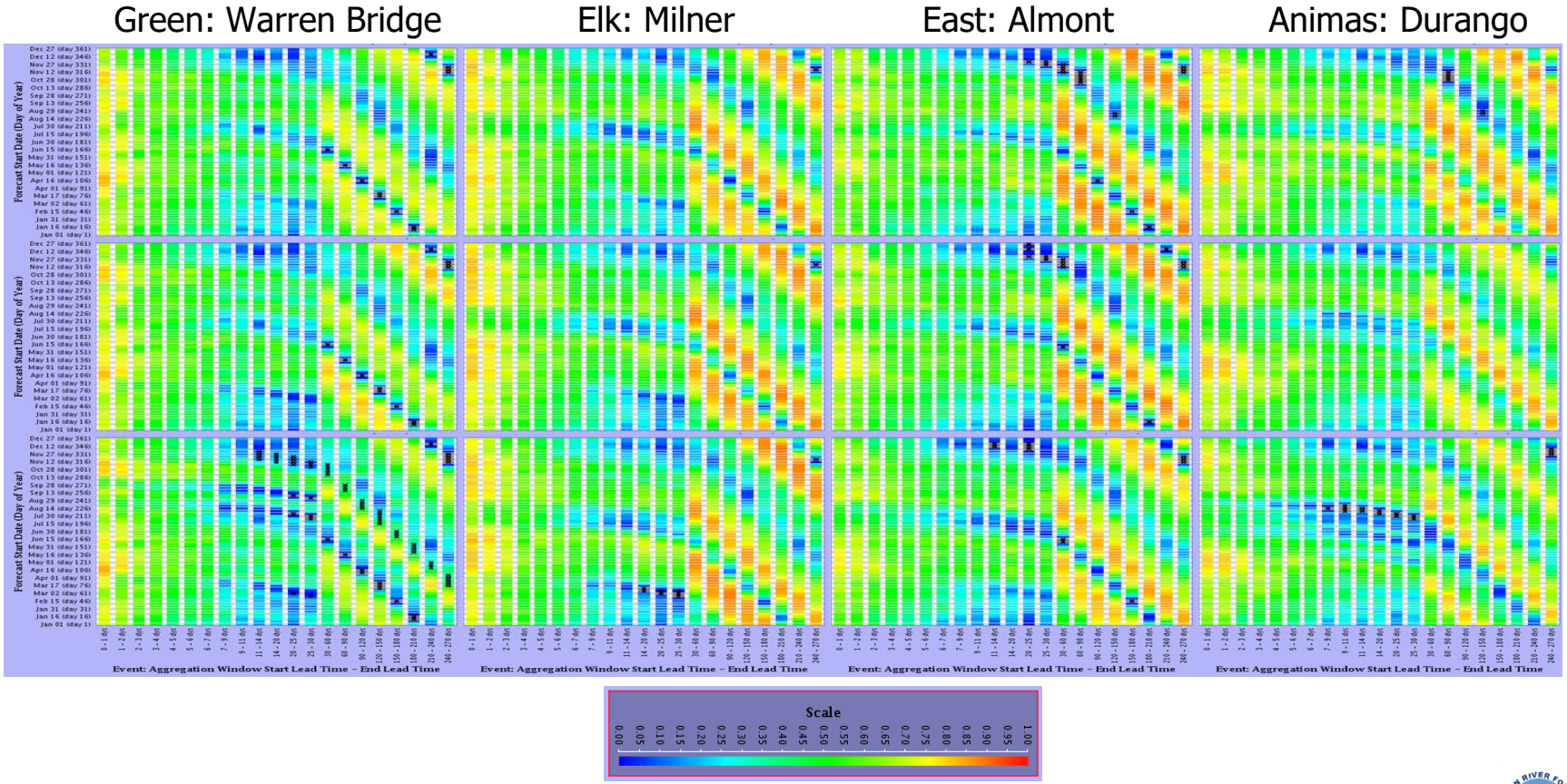
Seasonal Forecast - Using CFSv2



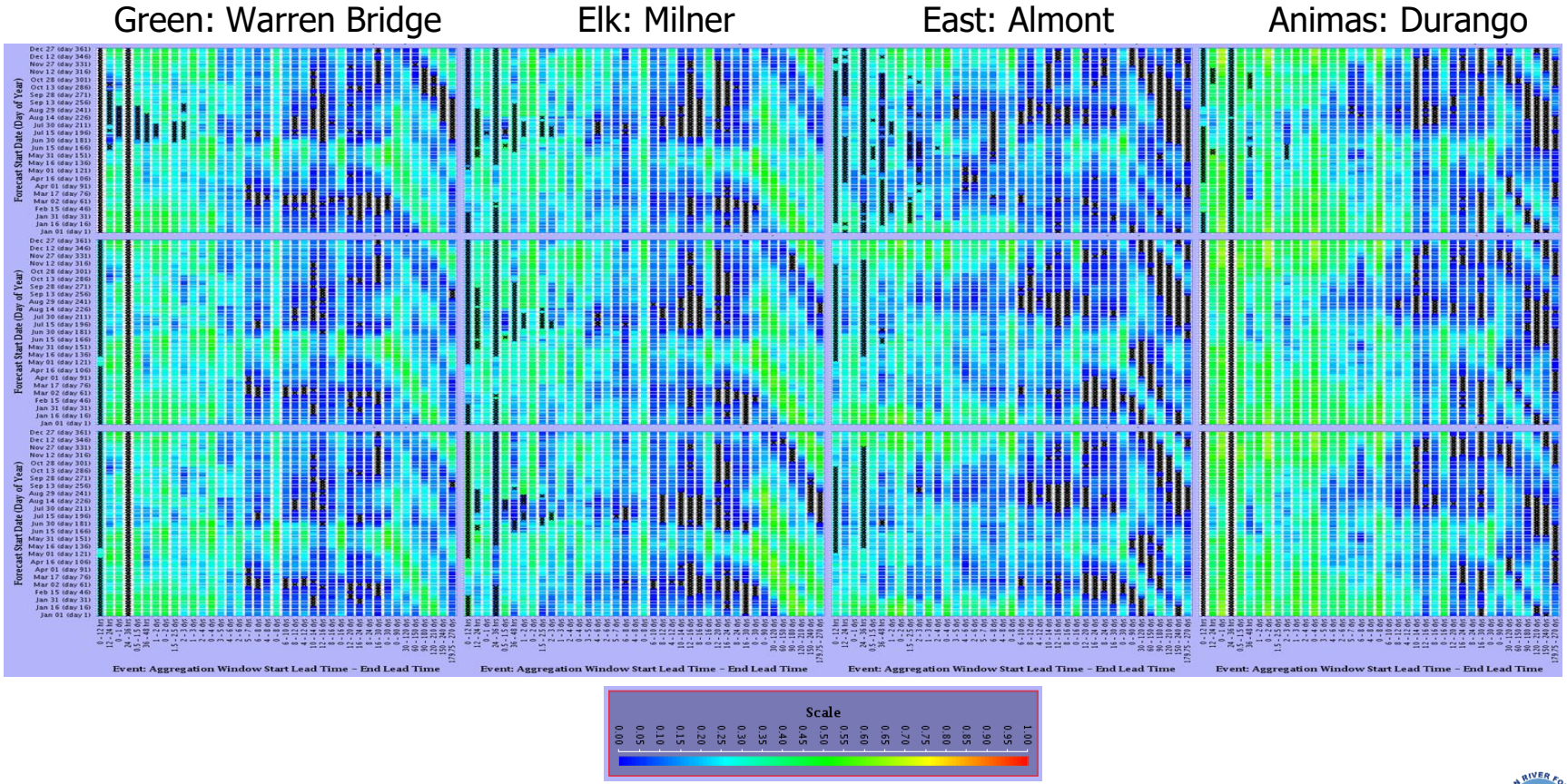
Seasonal Forecast - CFSv2 Temperature MAX Skill



Seasonal Forecast - CFSv2 Temperature MIN Skill

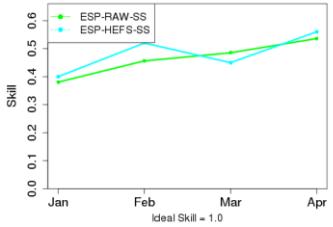


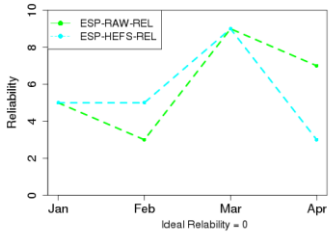
Seasonal Forecast - CFSv2 Precipitation Skill

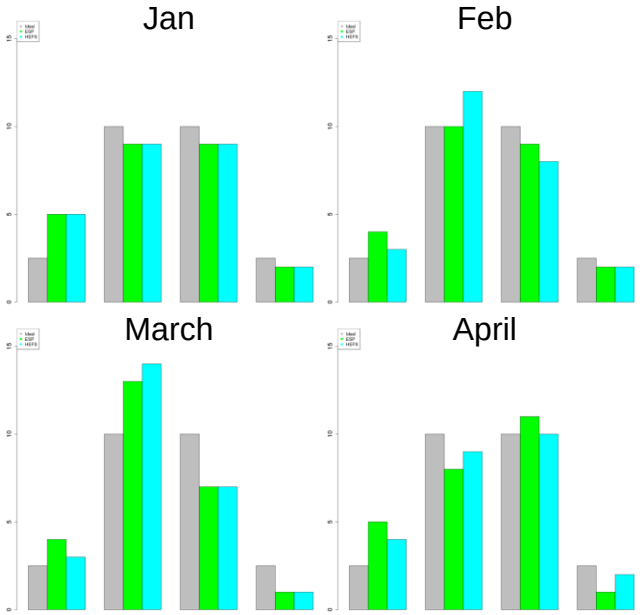


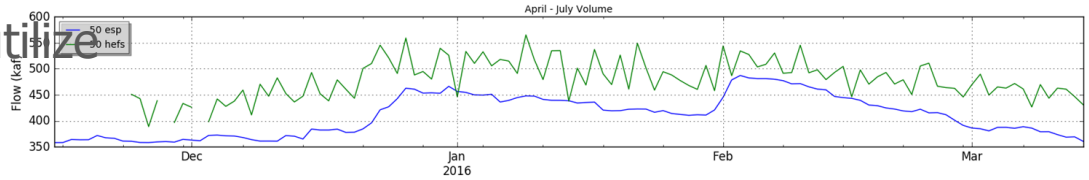
Adding Seasonal Forecast Thoughts

- Little, if any, skill added with GEFS/CFS forecast
  - not unexpected given not much skill in CFSv2
  - need to develop better CFSv2 forecast smoothing
- How does CFS forecast fair when looking at ENSO signal?
  - limited sample size so it will be difficult to draw any conclusions from
- In general more skillful S2S forecasts are needed to fully utilize in HEFS framework for water supply forecasting.









Questions?

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