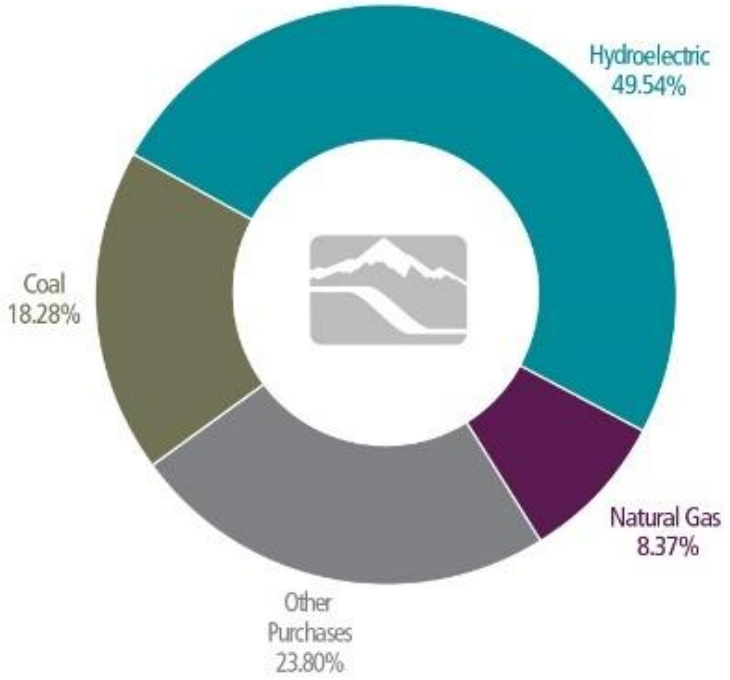
Idaho Power Company Enhanced Forecast System

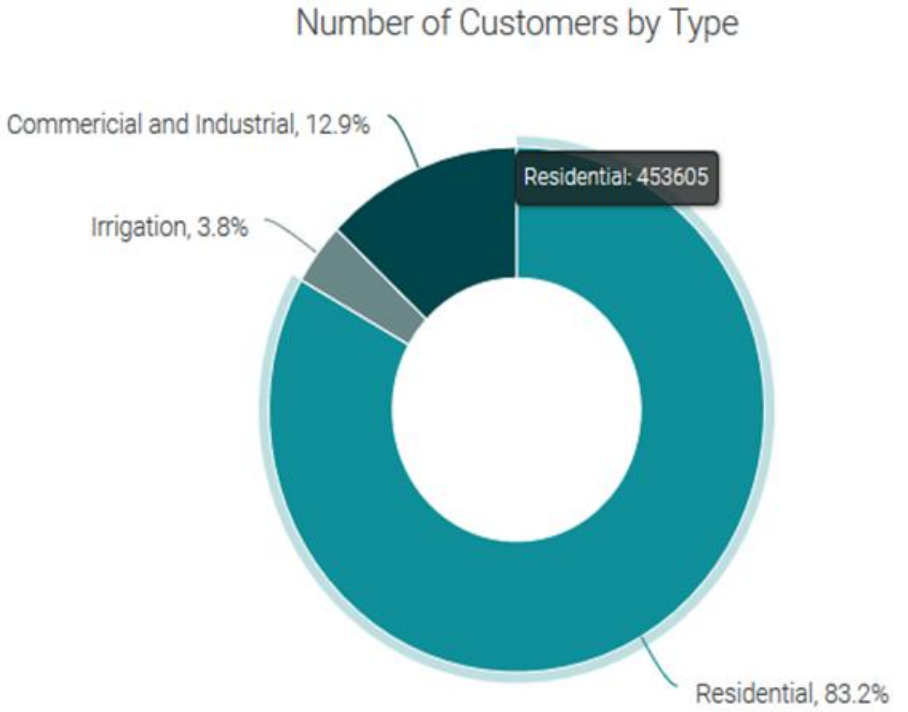
Nick Dawson and John Hildreth

March 14, 2019

Idaho Power's Company Statistics

2017 Energy Portfolio

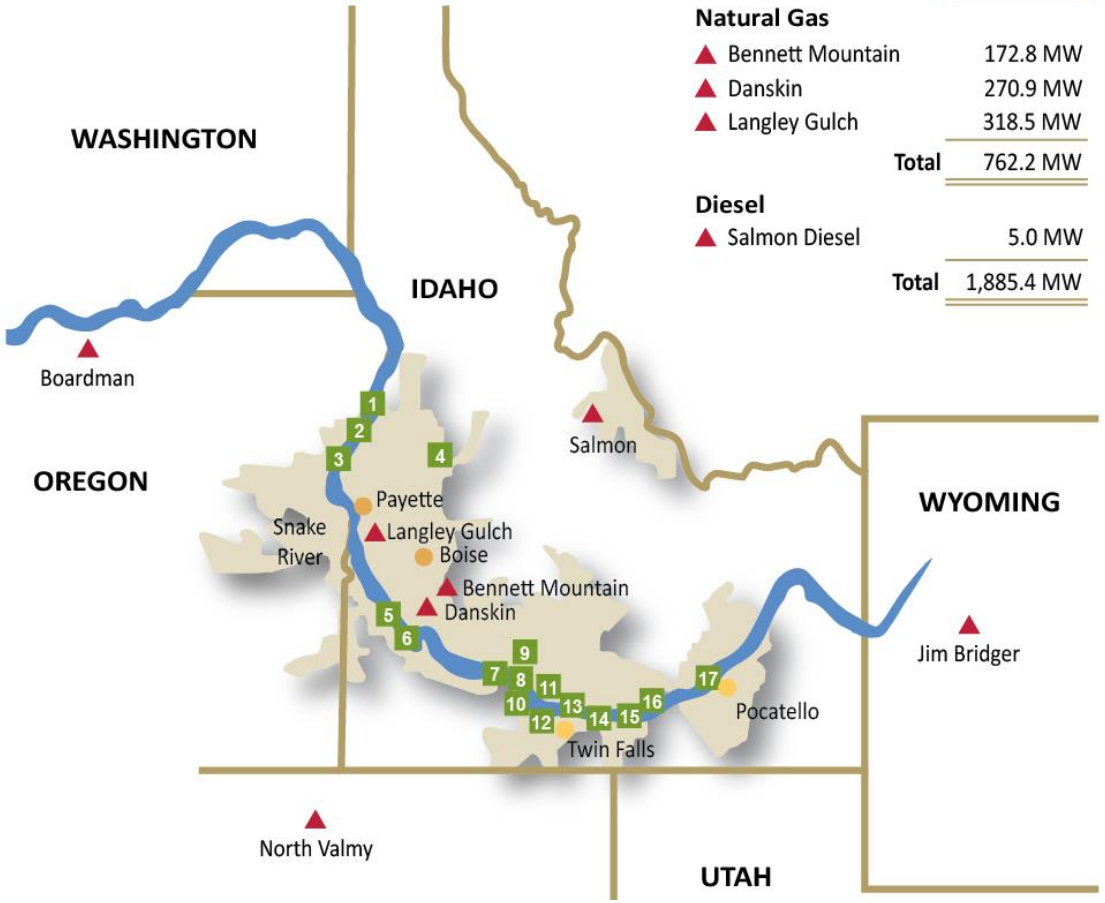




Snake River Basin

Hydroelectric Facilities and Nameplate Capacities

1	Hells Canyon	391.5 MW
2	Oxbow	190.0 MW
3	Brownlee	585.4 MW
4	Cascade	12.4 MW
5	Swan Falls	27.2 MW
6	C. J. Strike	82.8 MW
7	Bliss	75.0 MW
8	Lower Malad	13.5 MW
9	Upper Malad	8.3 MW
10	Lower Salmon	60.0 MW
11	Upper Salmon	34.5 MW
12	Thousand Springs	8.8 MW
13	Clear Lake	2.5 MW
14	Shoshone Falls	12.5 MW
15	Twin Falls	52.9 MW
16	Milner	59.4 MW
17	American Falls	92.3 MW
	Total	1,709.0 MW



Thermal Facilities And Capacities

Coal

Jim Bridger	770.5 MW*
North Valmy	283.5 MW*
Boardman	64.2 MW*
Total	1,118.2 MW

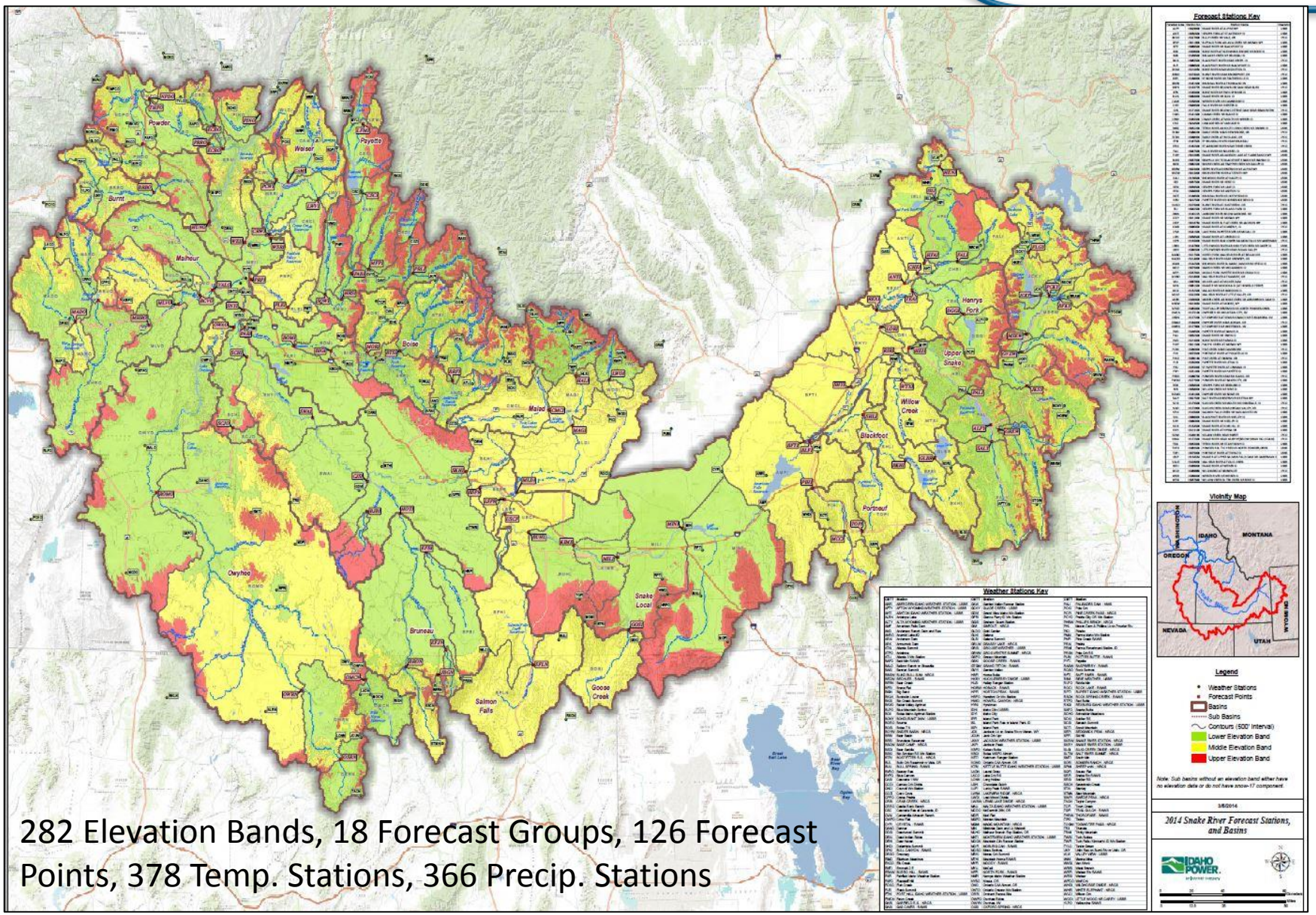
Natural Gas

Bennett Mountain	172.8 MW
Danskin	270.9 MW
Langley Gulch	318.5 MW
Total	762.2 MW

Diesel

Salmon Diesel	5.0 MW
Total	1,885.4 MW

Snake River Basin



282 Elevation Bands, 18 Forecast Groups, 126 Forecast Points, 378 Temp. Stations, 366 Precip. Stations

Background of FEWS at IPC

- Meteorological Forecasting
  - Custom program called Mr. Bill to generate point data for NWSRFS platform
  - FEWS pilot project started in 2014 in standalone
  - Typical forecast takes between 15 minutes to an hour depending on weather
  - Output is merged in the streamflow forecast workflows
- Streamflow Forecasting
  - Existing system and models in NWSRFS platform
  - Pilot Project started in 2014 to show proof of concept
    - RiverWare functionality demonstrated
  - Full migration project started in 2016 finished in 2018
    - “Live System” with automated data feeds and running tasks
    - Calibration System (standalone)
    - Historical System (standalone)
    - Additional Features (Archive, QA/QC, new basins)
    - Publishing
- Water Quality Modeling
  - Concept design in 2014, model development started in 2017 finished in 2018
  - ‘Hindcast’ Scenarios (standalone)

Meteorological Forecasting System

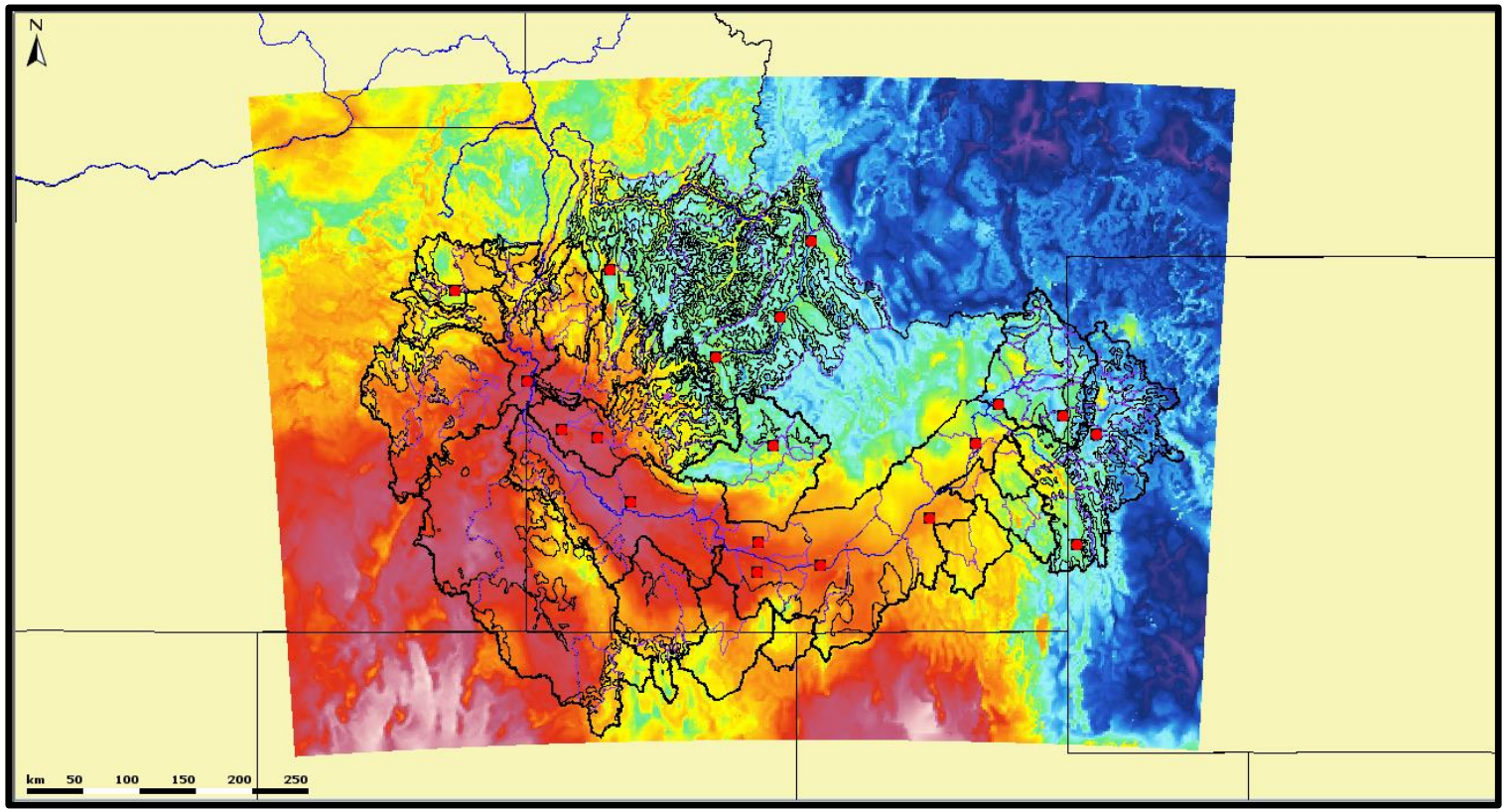
Meteorology Forecast Workflow

1. Ingest weather models
    1. Weather Research and Forecasting (WRF) model
    2. Operational weather models (GFS and NAM primarily)

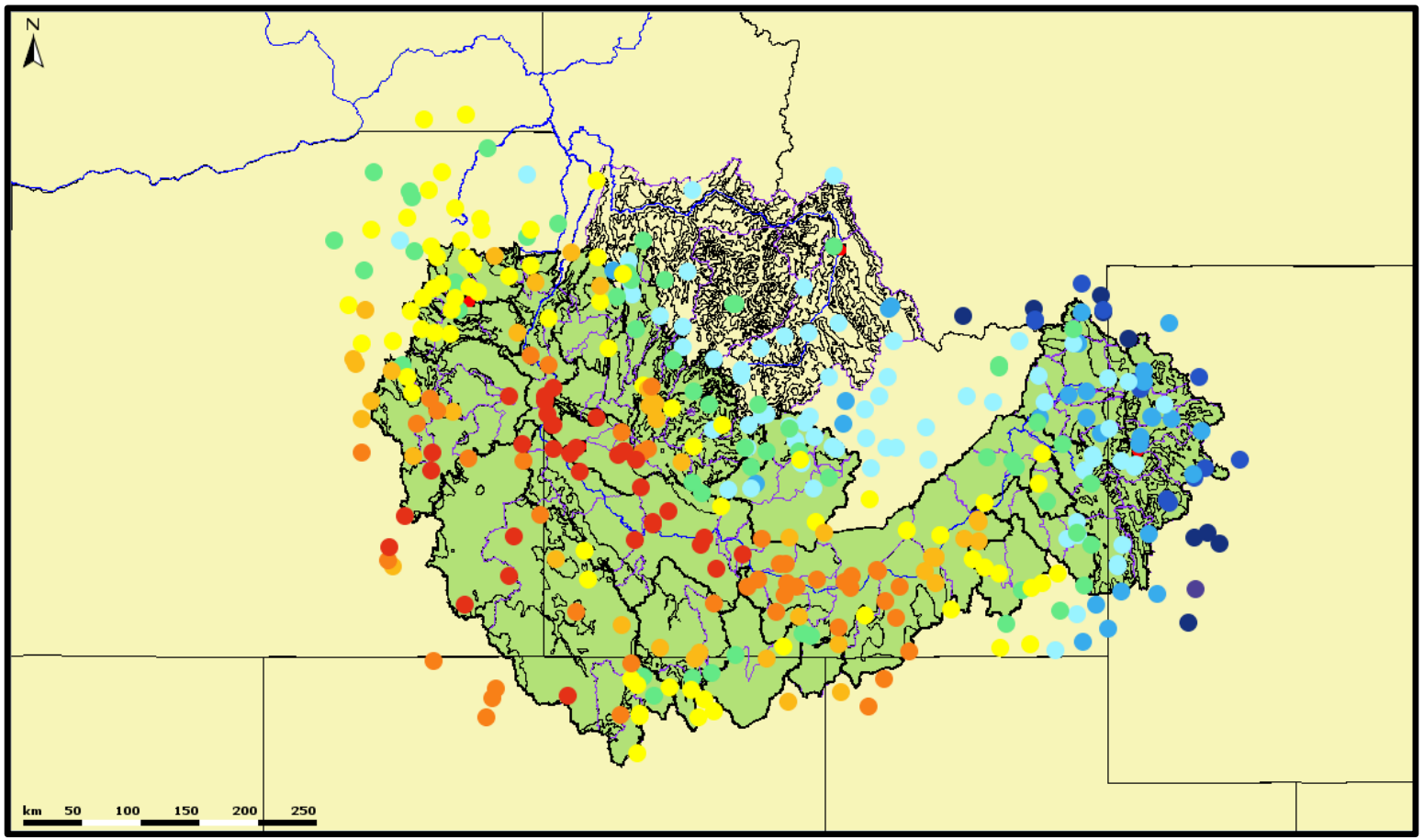
2. Preprocess imported models
3. Forecast Mixer
4. Thresholding
5. Calculate Mean Areal Temperature/Precipitation timeseries
6. Blended short term and climatology timeseries

Ingest and Preprocessing

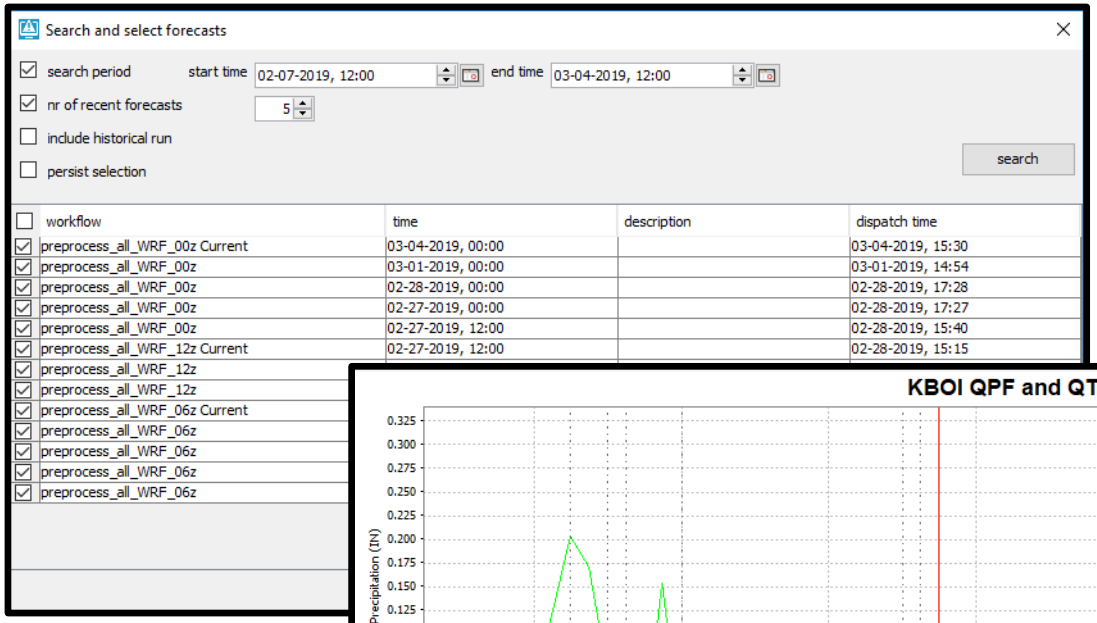
Import GRIB2 data from an Apache Tomcat server

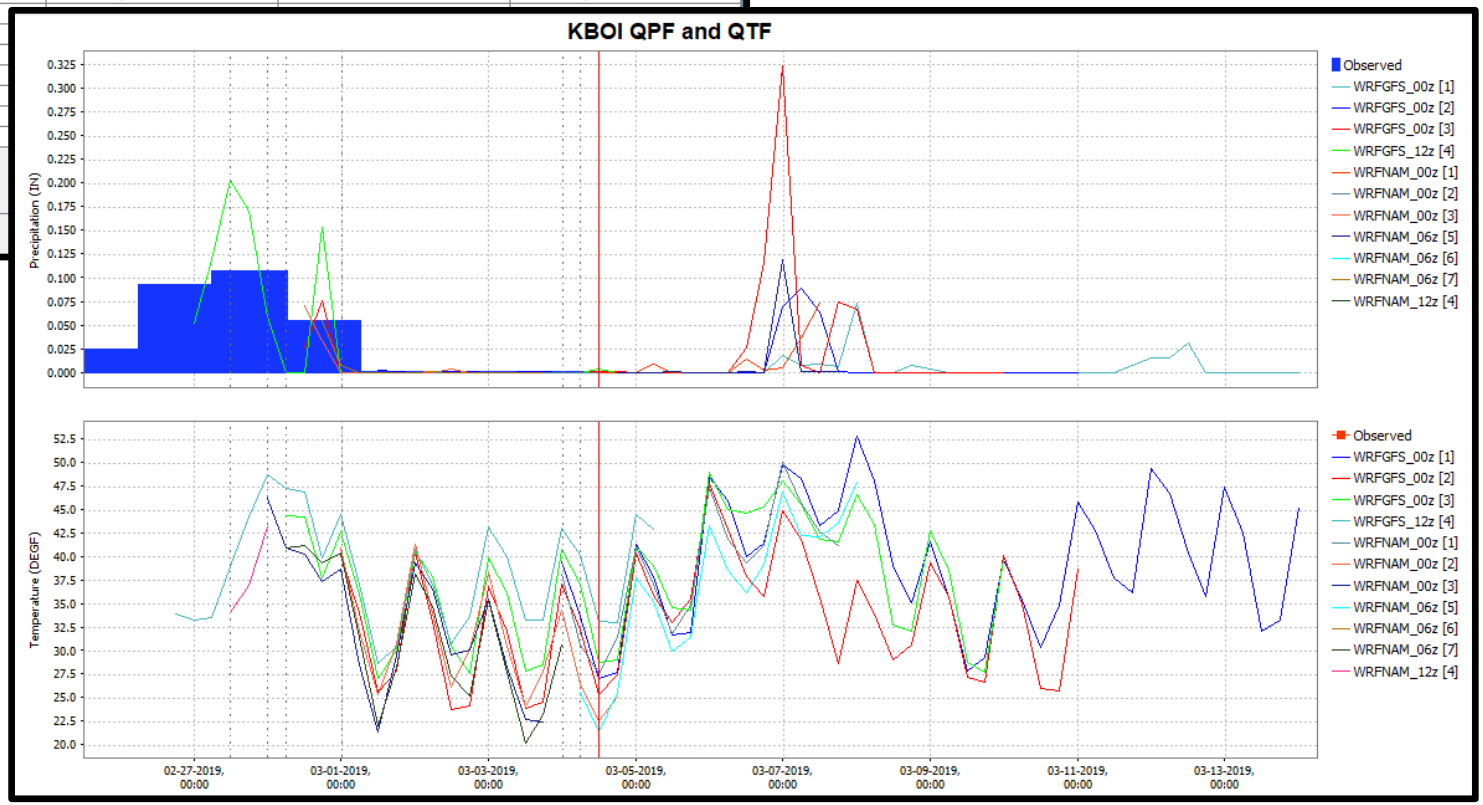


Preprocess Forecast Points

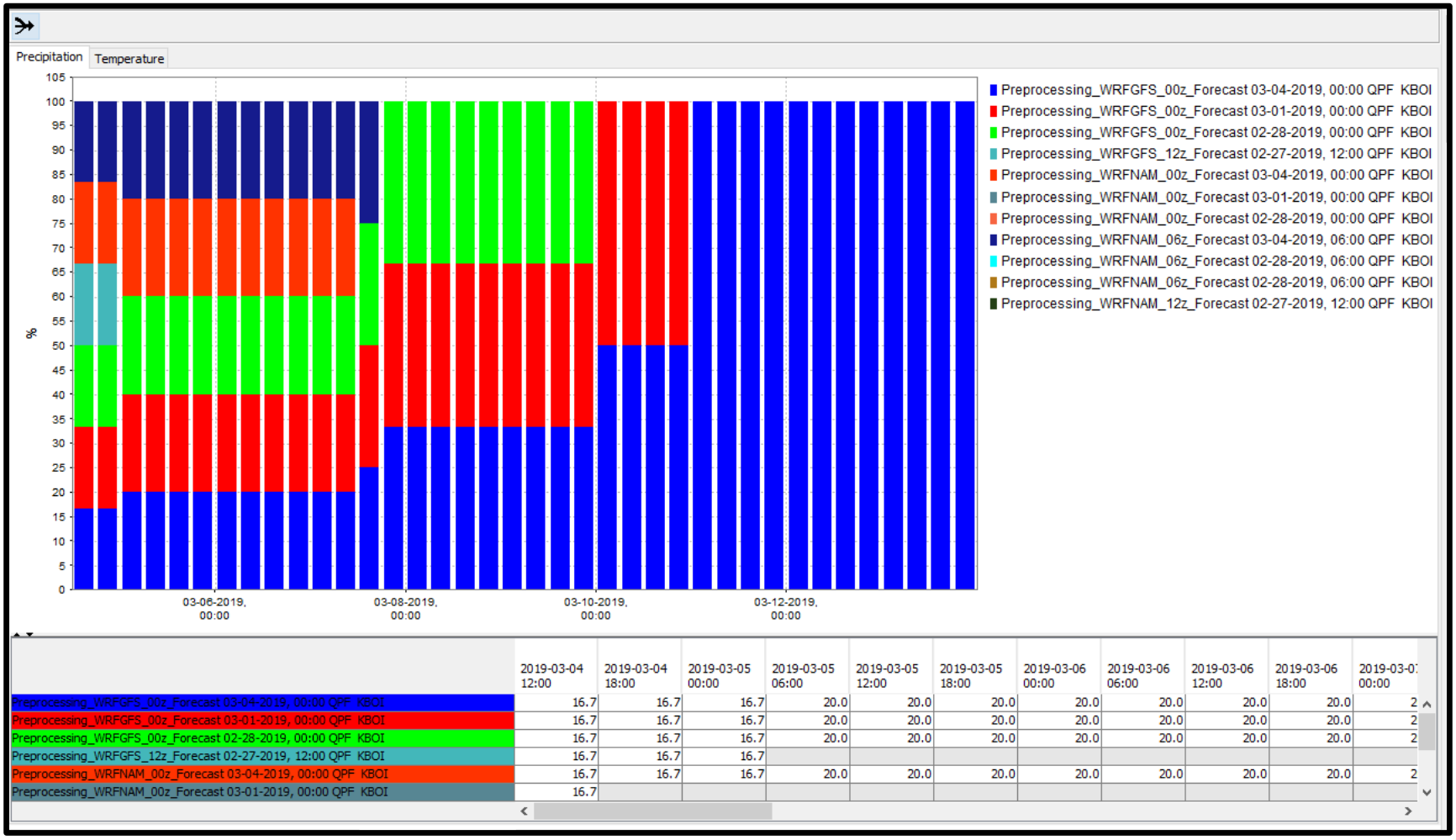


Forecast Mixer



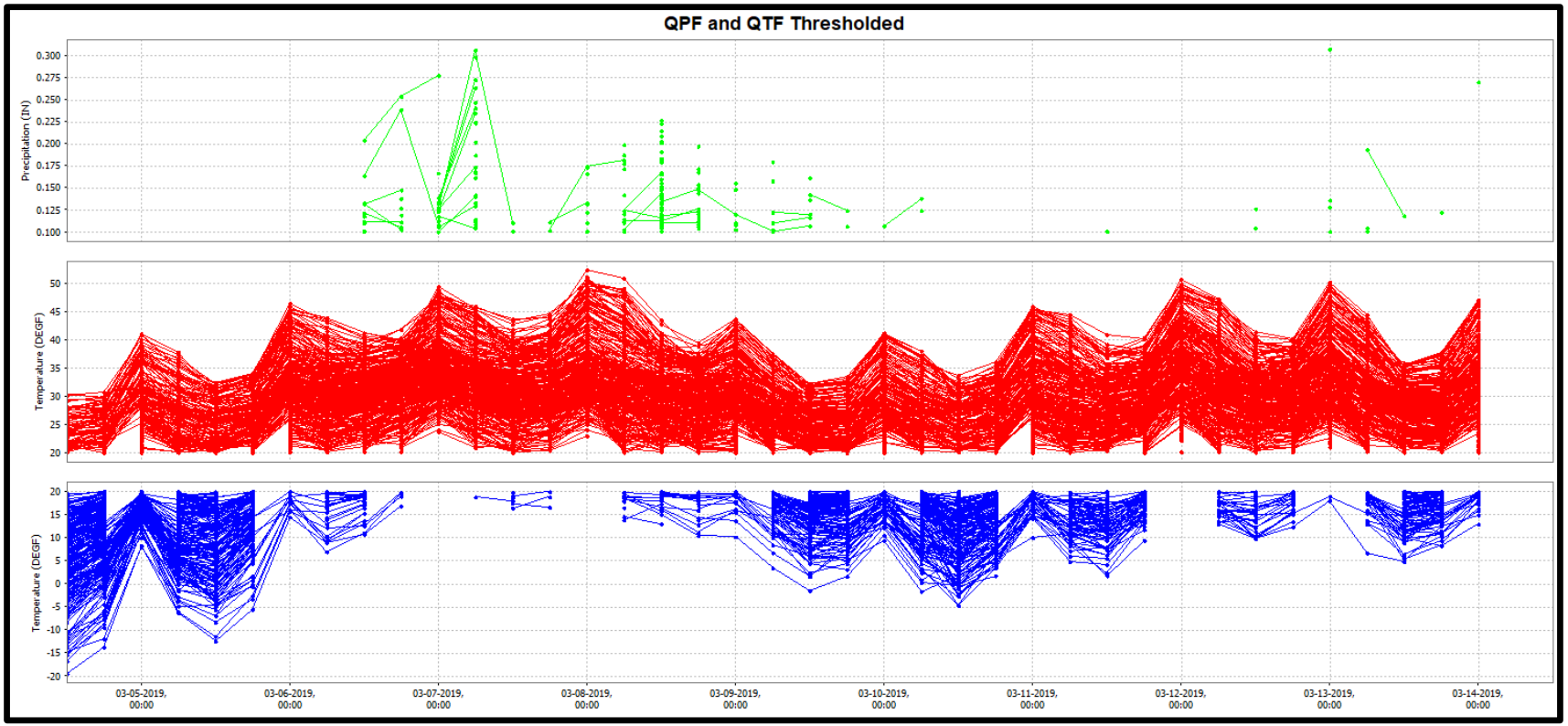


Forecast Mixer

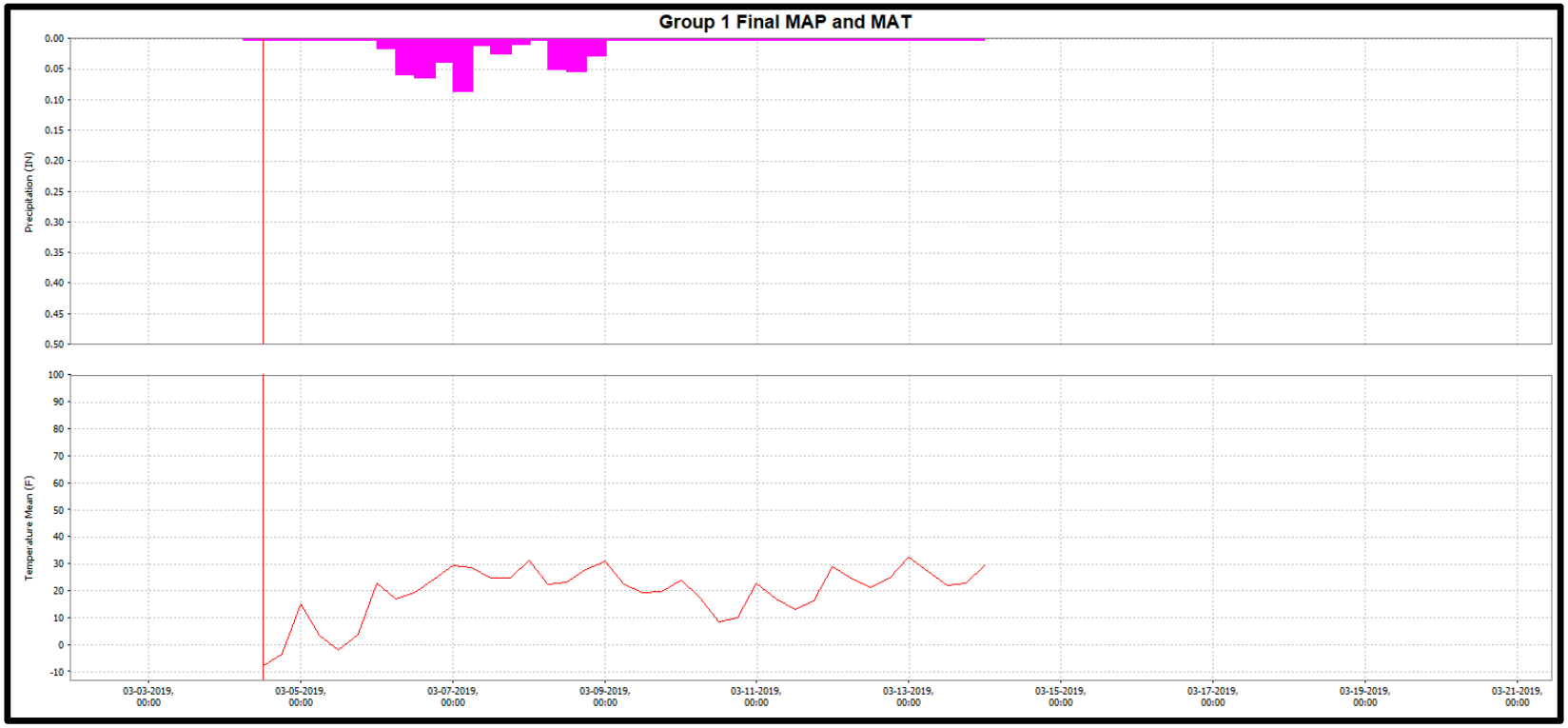


	2019-03-04 12:00	2019-03-04 18:00	2019-03-05 00:00	2019-03-05 06:00	2019-03-05 12:00	2019-03-05 18:00	2019-03-06 00:00	2019-03-06 06:00	2019-03-06 12:00	2019-03-06 18:00	2019-03-0 00:00
Preprocessing_WRFGFS_00z_Forecast 03-04-2019, 00:00 QPF KBOI	16.7	16.7	16.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	2
Preprocessing_WRFGFS_00z_Forecast 03-01-2019, 00:00 QPF KBOI	16.7	16.7	16.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	2
Preprocessing_WRFGFS_00z_Forecast 02-28-2019, 00:00 QPF KBOI	16.7	16.7	16.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	2
Preprocessing_WRFGFS_12z_Forecast 02-27-2019, 12:00 QPF KBOI	16.7	16.7	16.7								
Preprocessing_WRFNAM_00z_Forecast 03-04-2019, 00:00 QPF KBOI	16.7	16.7	16.7	20.0	20.0	20.0	20.0	20.0	20.0	20.0	2
Preprocessing_WRFNAM_00z_Forecast 03-01-2019, 00:00 QPF KBOI	16.7										

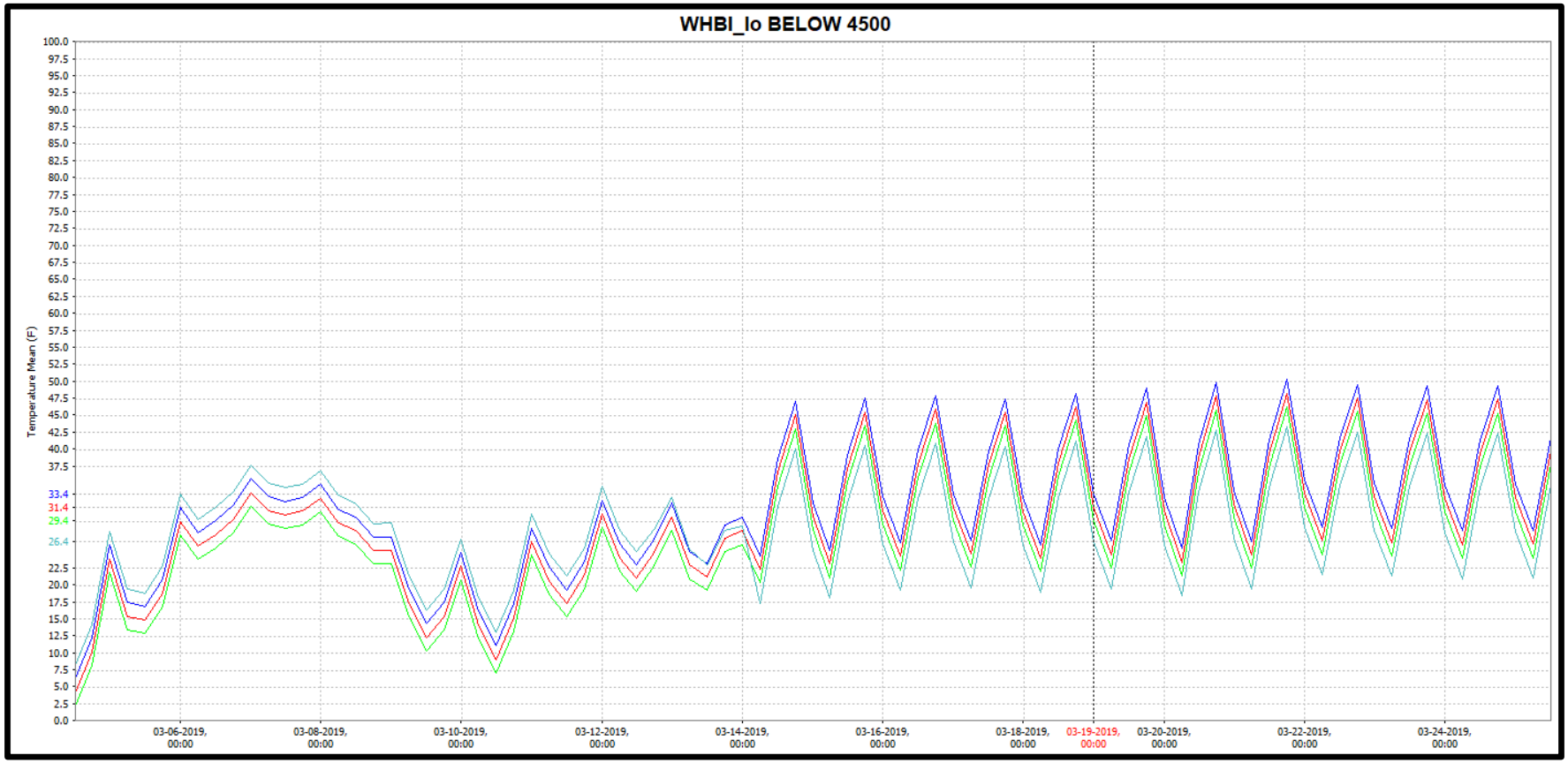
Thresholds


QPF and QTF Thresholded
Precipitation (IN)
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
Temperature (DEGF)
50
45
40
35
30
25
20
Temperature (DEGF)
20
15
10
5
0
-5
-10
-15
-20
03-05-2019, 00:00
03-06-2019, 00:00
03-07-2019, 00:00
03-08-2019, 00:00
03-09-2019, 00:00
03-10-2019, 00:00
03-11-2019, 00:00
03-12-2019, 00:00
03-13-2019, 00:00
03-14-2019, 00:00

Create short term MAP & MAT



Blend short term with Climatology

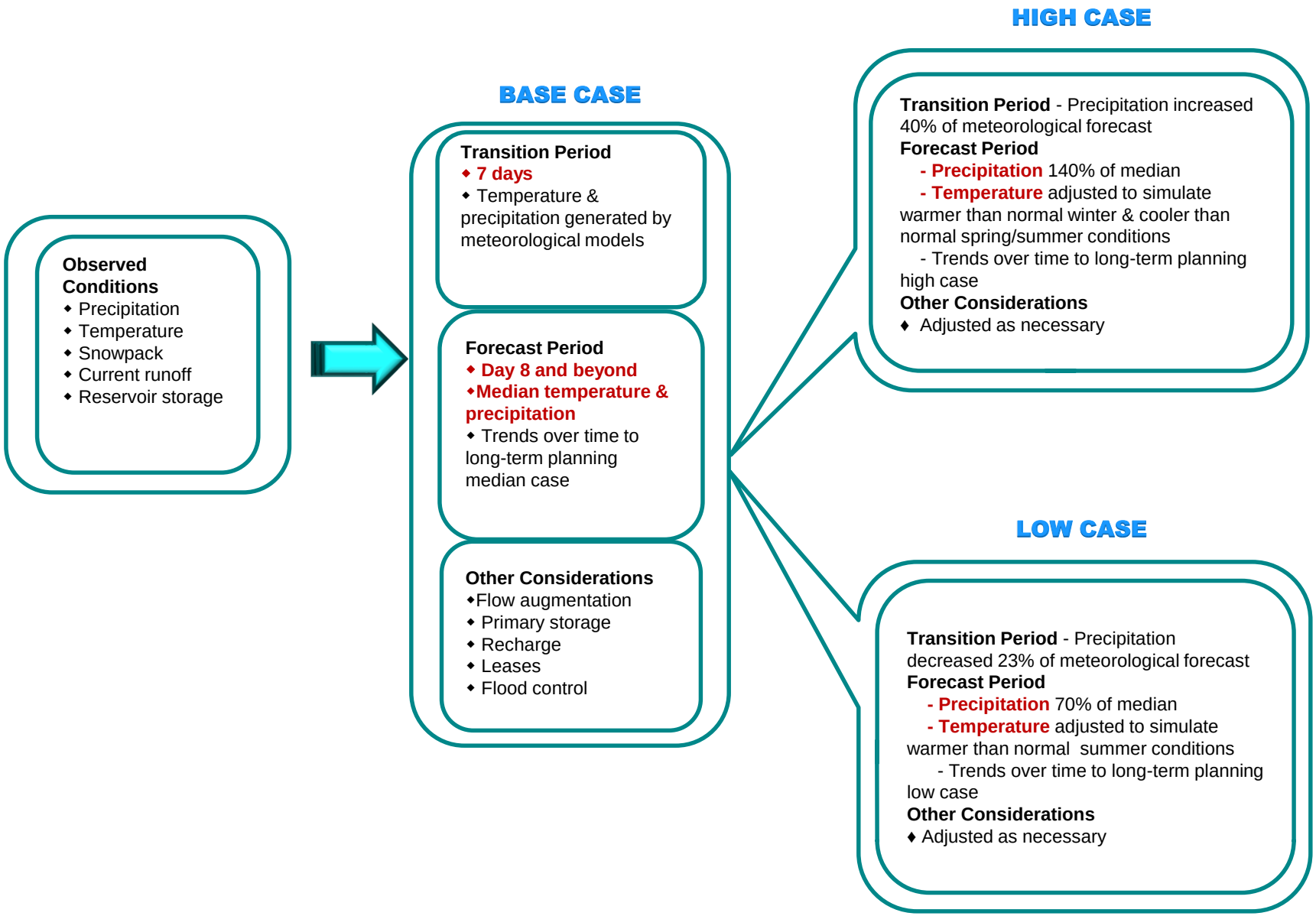


Streamflow Forecasting System

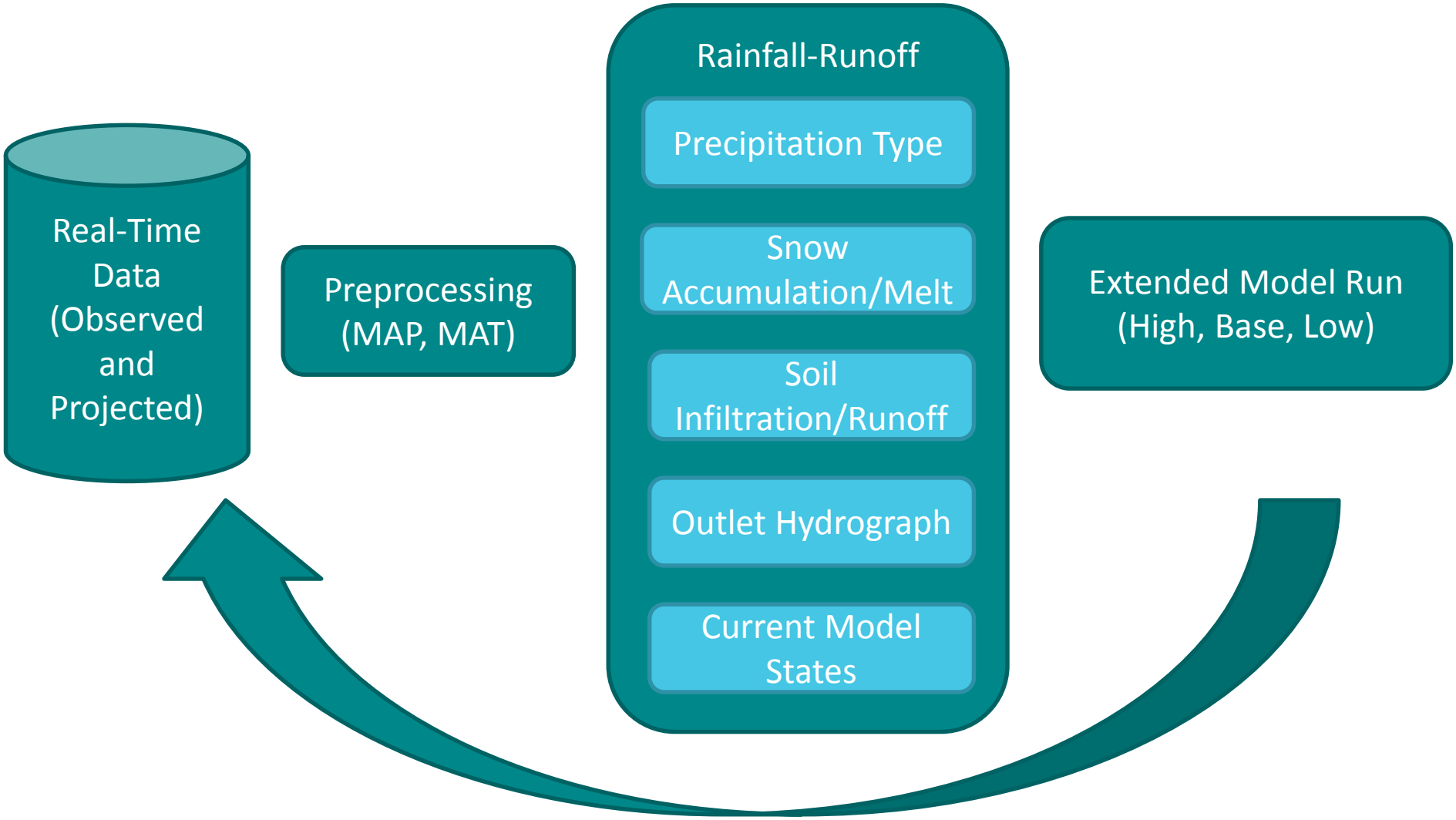
Forecast Horizons

- Three products available to our internal customers
- Raw model results (SG Trace)
  - 6-hour data available for all locations in model for the FEWS run length
- Timeseries of daily streamflow (15 locations) and reservoir pool elevations (2 locations)
  - Short-Term Forecast
    - Extends out 1-2 months
    - Publish two forecasts per week
  - Long-Term Forecast
    - Extends out 24 months

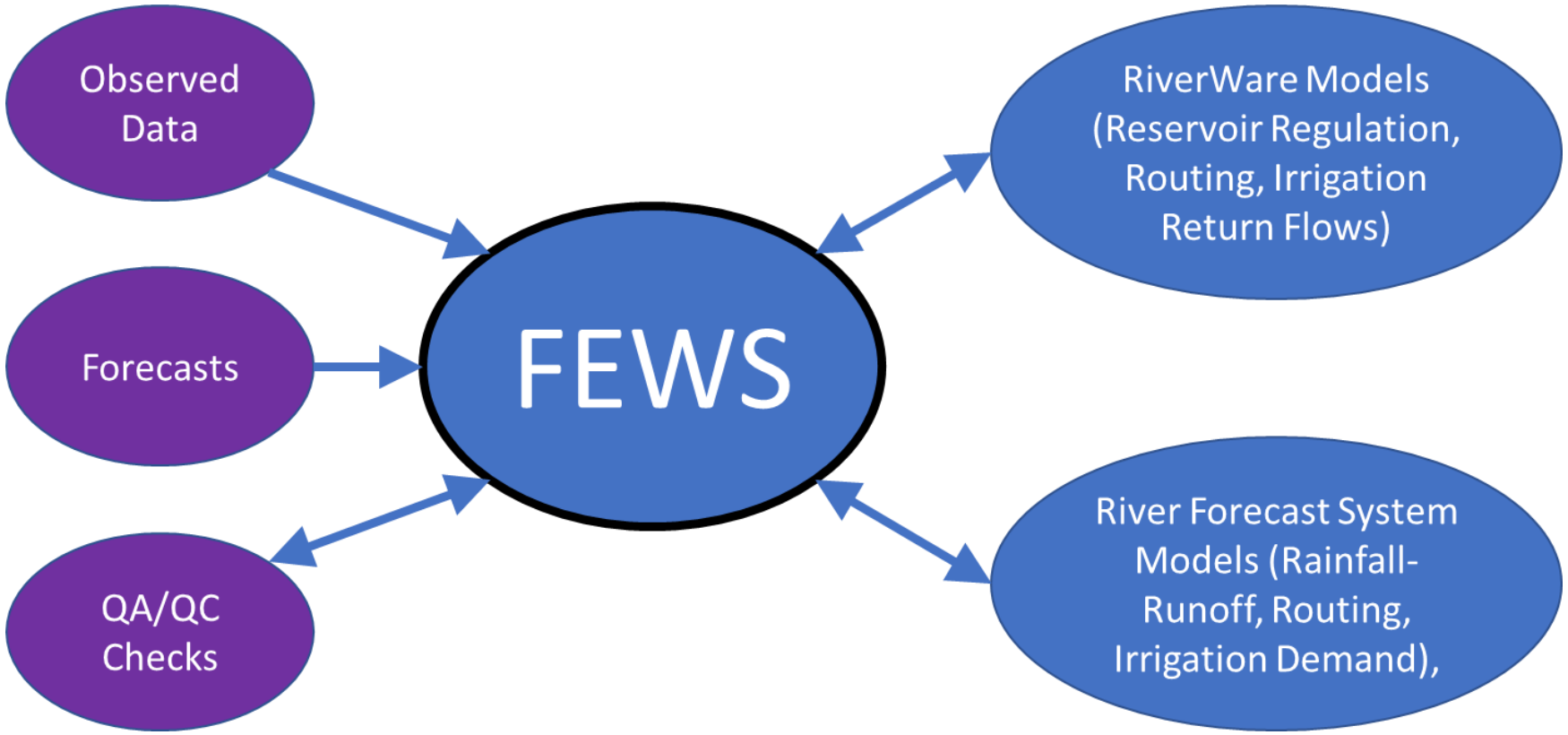
Streamflow “Cases”



National Weather Service River Forecast System (NWSRFS)

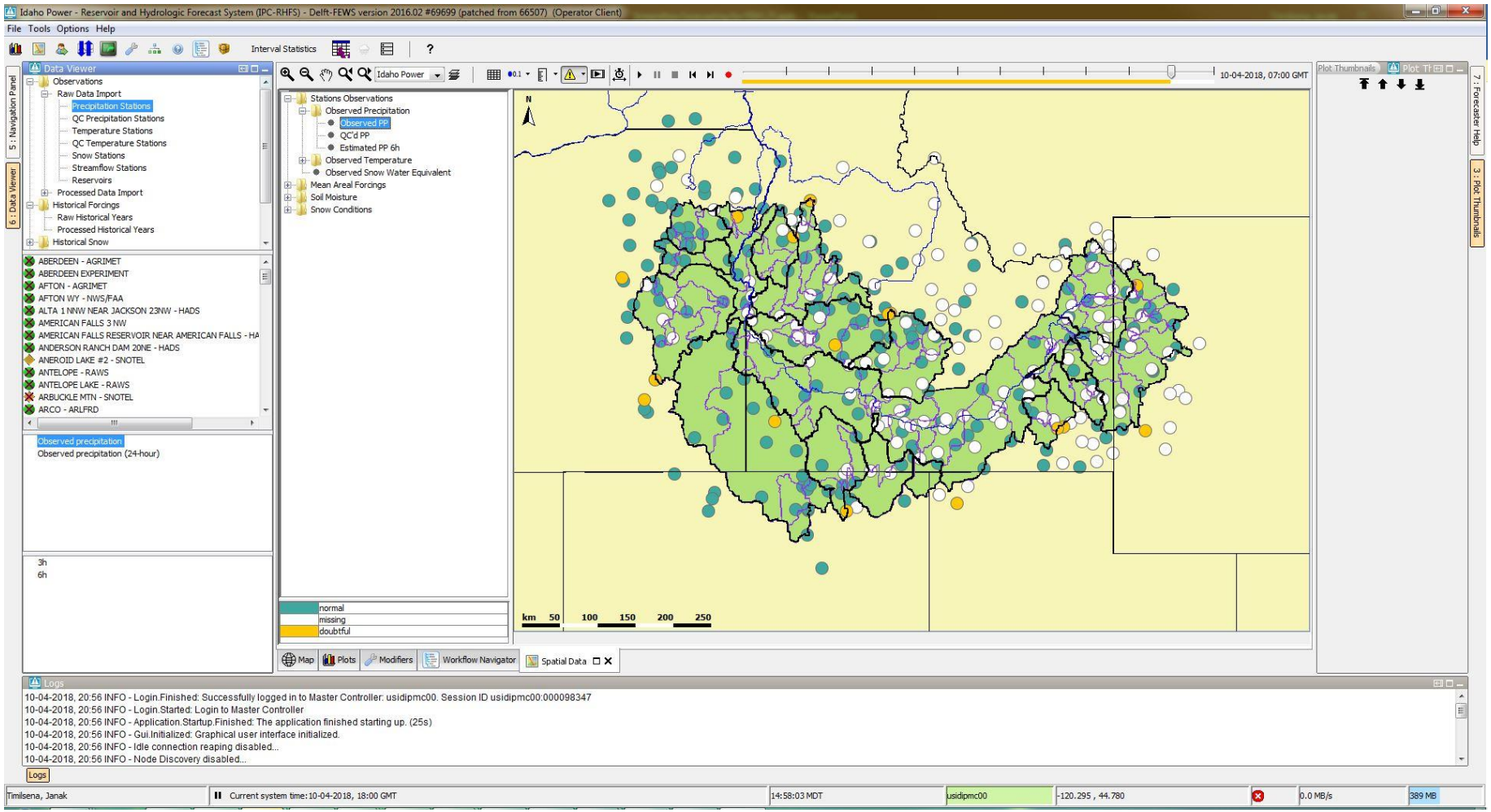


Enhanced Forecast System (EFS)

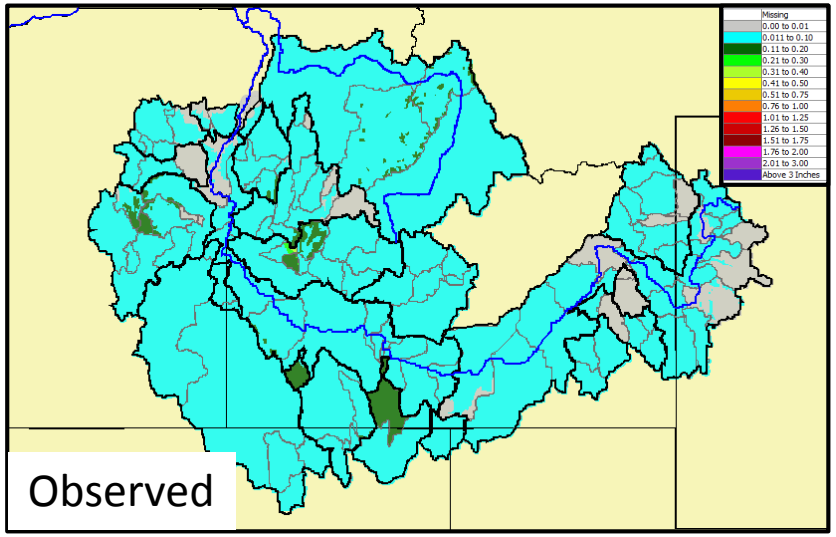


Deltares
Enabling Delta Life

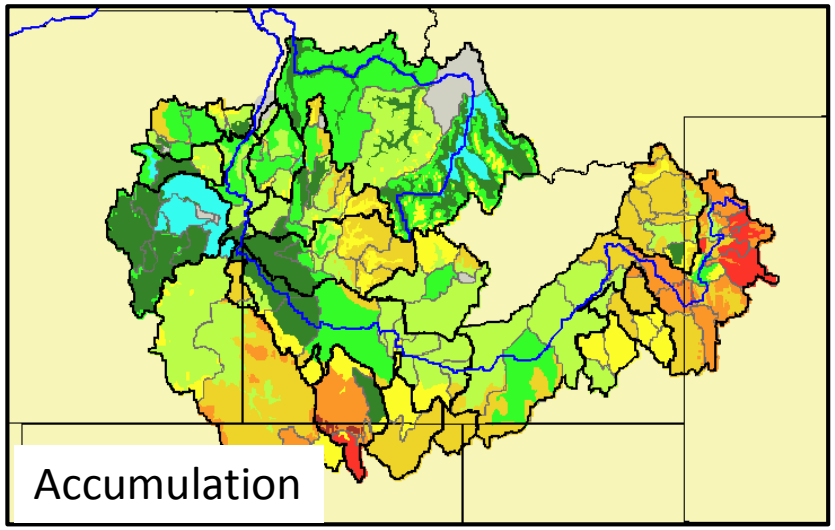
QA/QC Interface



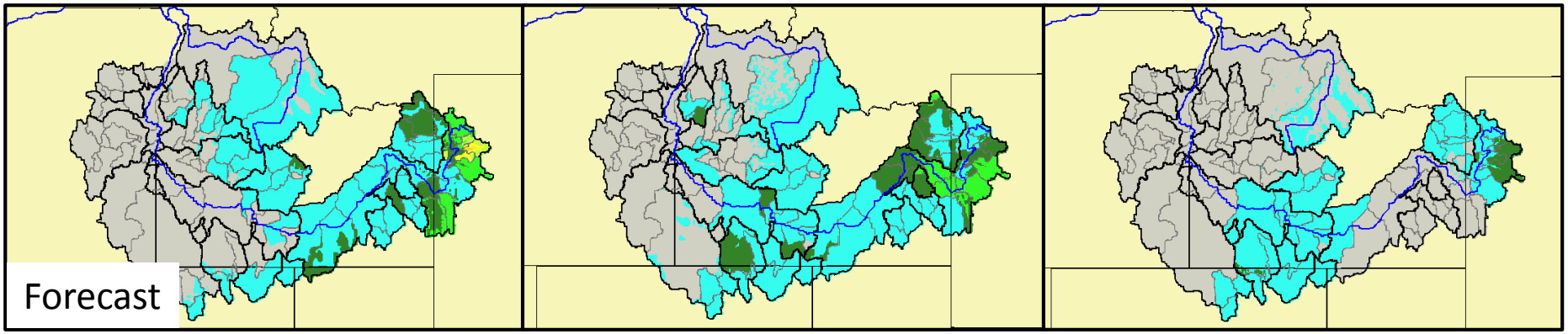
MAP and FMAP



Observed

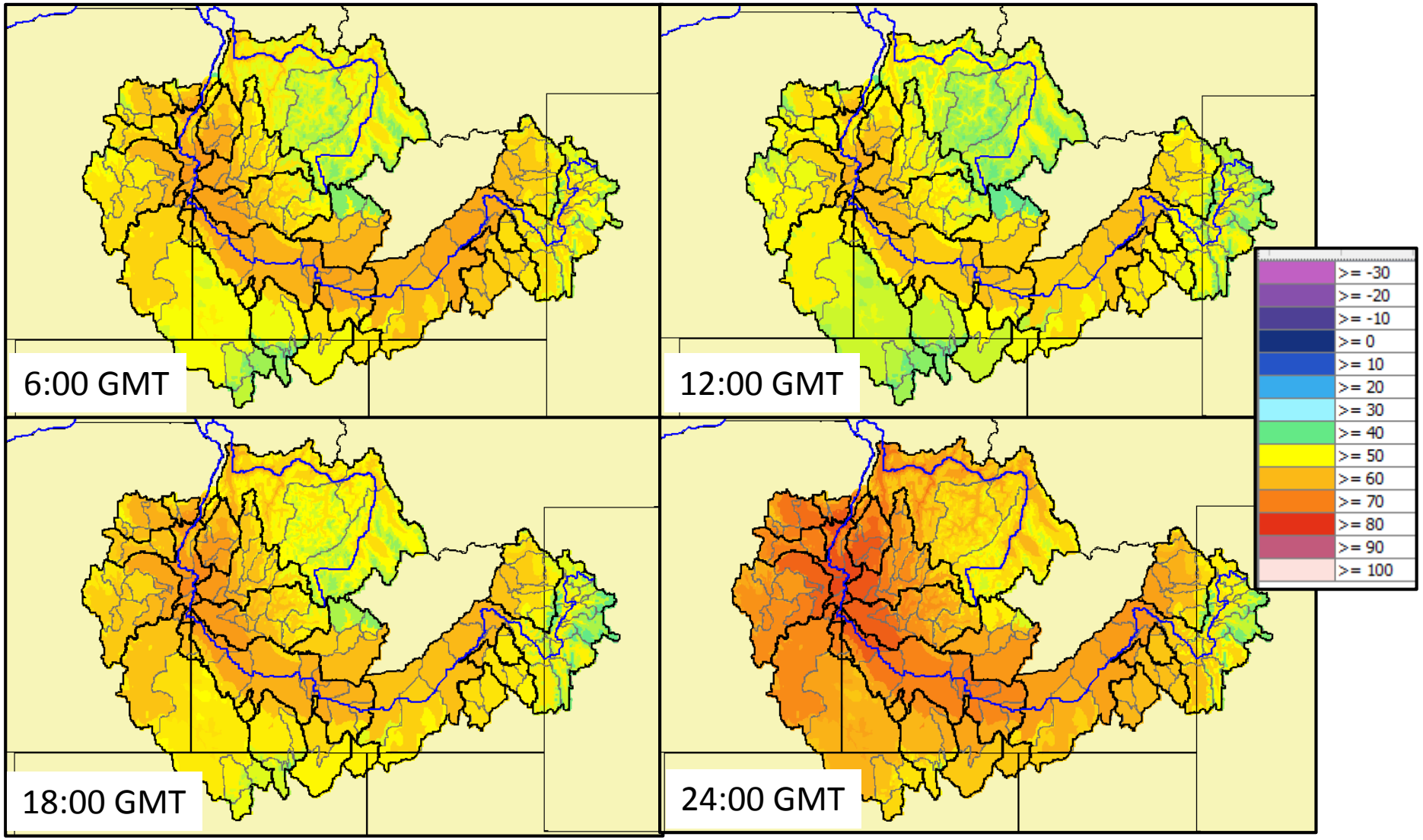


Accumulation

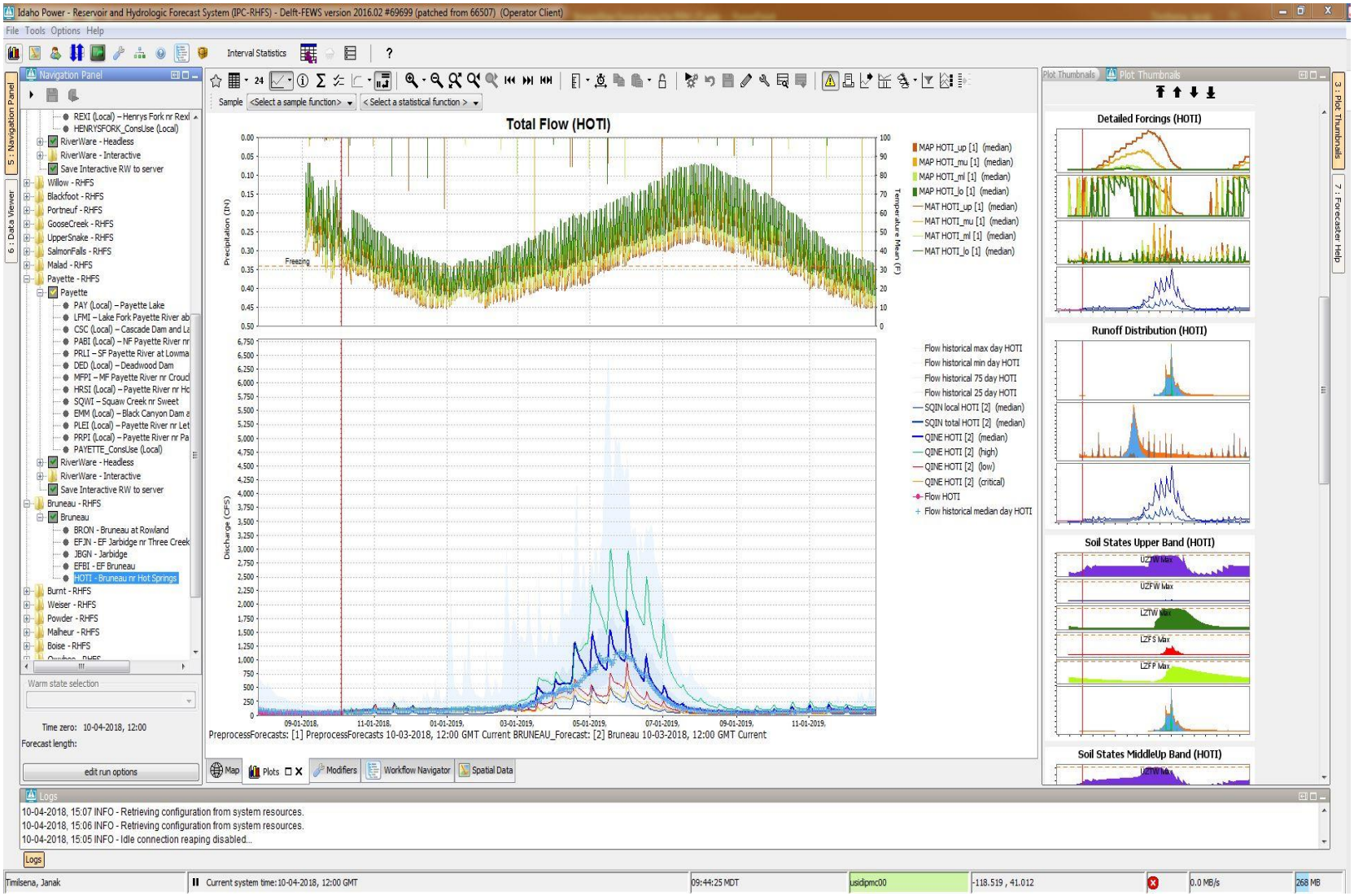


Forecast

MAT and FMAT


6:00 GMT
12:00 GMT
18:00 GMT
24:00 GMT
>= -30
>= -20
>= -10
>= 0
>= 10
>= 20
>= 30
>= 40
>= 50
>= 60
>= 70
>= 80
>= 90
>= 100

Long Range View



Reservoir Storage

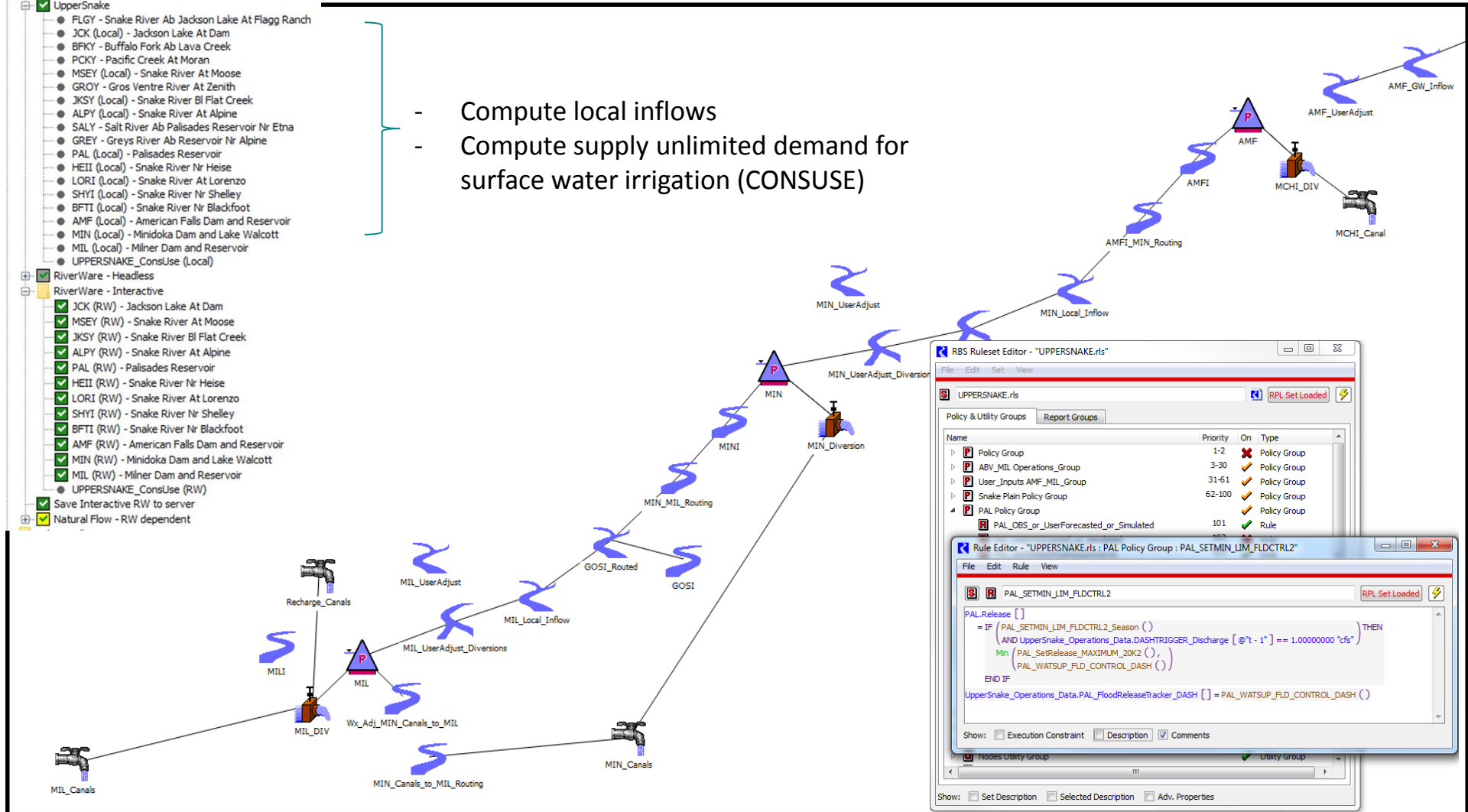
Reservoir Regulation (RiverWare)

Center for Advanced Decision Support for Water and Environmental Systems
UNIVERSITY OF COLORADO BOULDER

RiverWare

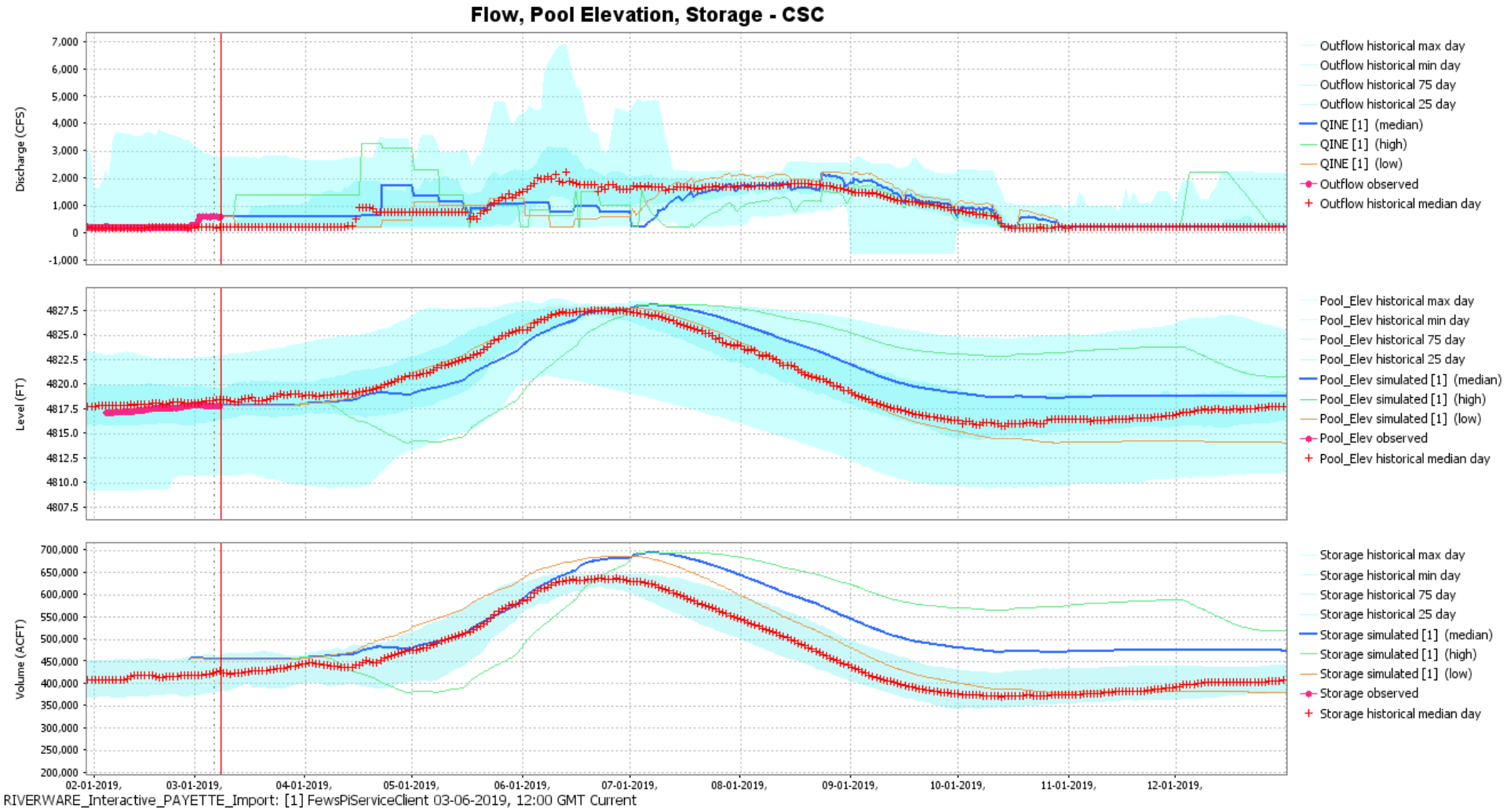
- UpperSnake - RHFS
  - UpperSnake
    - FLGY - Snake River Ab Jackson Lake At Flagg Ranch
    - JCK (Local) - Jackson Lake At Dam
    - BFKY - Buffalo Fork Ab Lava Creek
    - PCKY - Pacific Creek At Moran
    - MSEY (Local) - Snake River At Moose
    - GROY - Gros Ventre River At Zenith
    - JKSY (Local) - Snake River Bl Flat Creek
    - ALPY (Local) - Snake River At Alpine
    - SALY - Salt River Ab Palisades Reservoir Nr Etna
    - GREY - Greys River Ab Reservoir Nr Alpine
    - PAL (Local) - Palisades Reservoir
    - HEII (Local) - Snake River Nr Heise
    - LORI (Local) - Snake River At Lorenzo
    - SHYI (Local) - Snake River Nr Shelley
    - BFTI (Local) - Snake River Nr Blackfoot
    - AMF (Local) - American Falls Dam and Reservoir
    - MIN (Local) - Minidoka Dam and Lake Walcott
    - MIL (Local) - Milner Dam and Reservoir
    - UPPERSNAKE_ConsUse (Local)
  - RiverWare - Headless
  - RiverWare - Interactive
    - JCK (RW) - Jackson Lake At Dam
    - MSEY (RW) - Snake River At Moose
    - JKSY (RW) - Snake River Bl Flat Creek
    - ALPY (RW) - Snake River At Alpine
    - PAL (RW) - Palisades Reservoir
    - HEII (RW) - Snake River Nr Heise
    - LORI (RW) - Snake River At Lorenzo
    - SHYI (RW) - Snake River Nr Shelley
    - BFTI (RW) - Snake River Nr Blackfoot
    - AMF (RW) - American Falls Dam and Reservoir
    - MIN (RW) - Minidoka Dam and Lake Walcott
    - MIL (RW) - Milner Dam and Reservoir
    - UPPERSNAKE_ConsUse (RW)
  - Save Interactive RW to server
  - Natural Flow - RW dependent

- Compute local inflows
- Compute supply unlimited demand for surface water irrigation (CONSUSE)

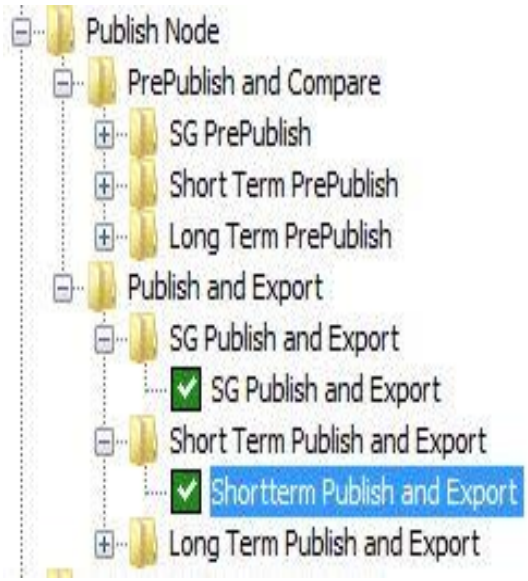


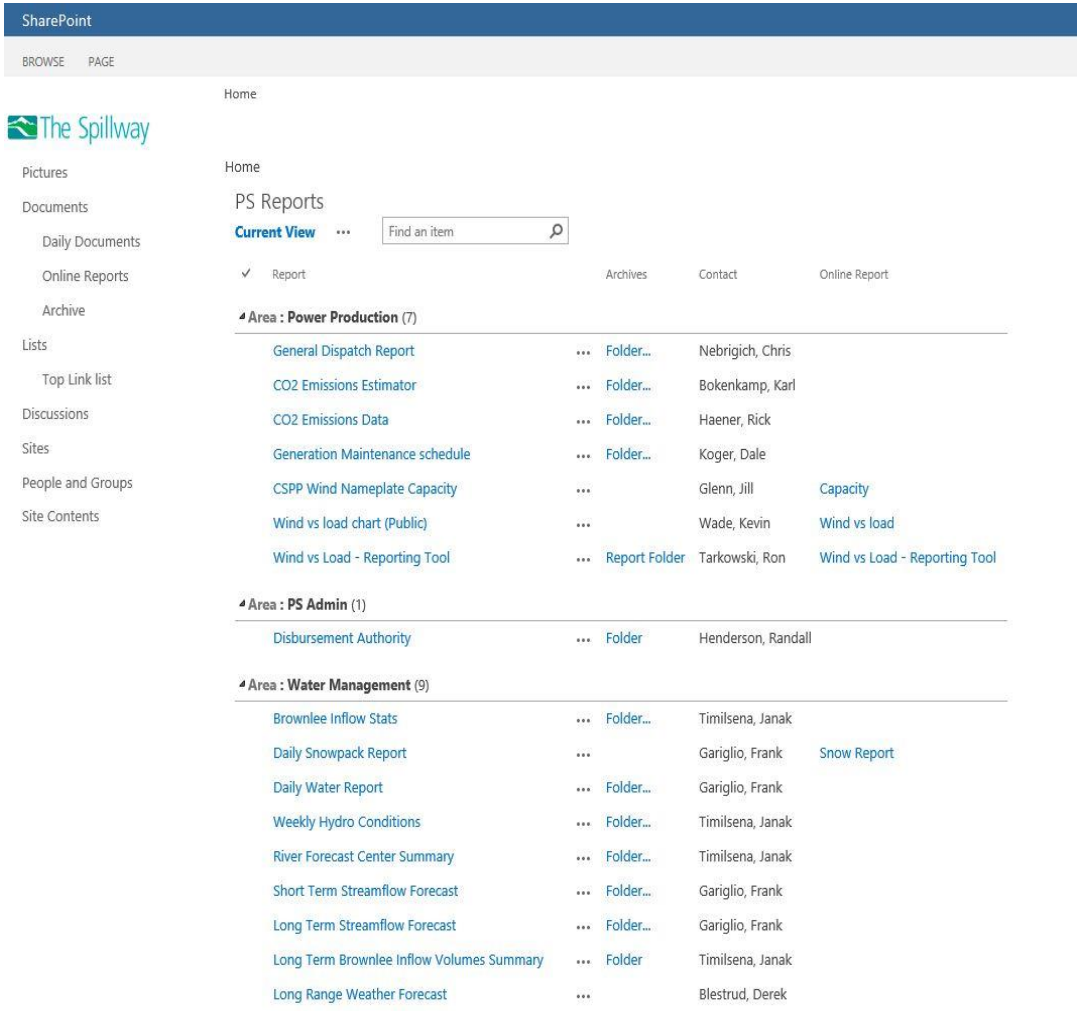
Interactive RiverWare Plots

RiverWare – Reservoir Operation



Publish Directly from FEWS





Water Quality Modeling

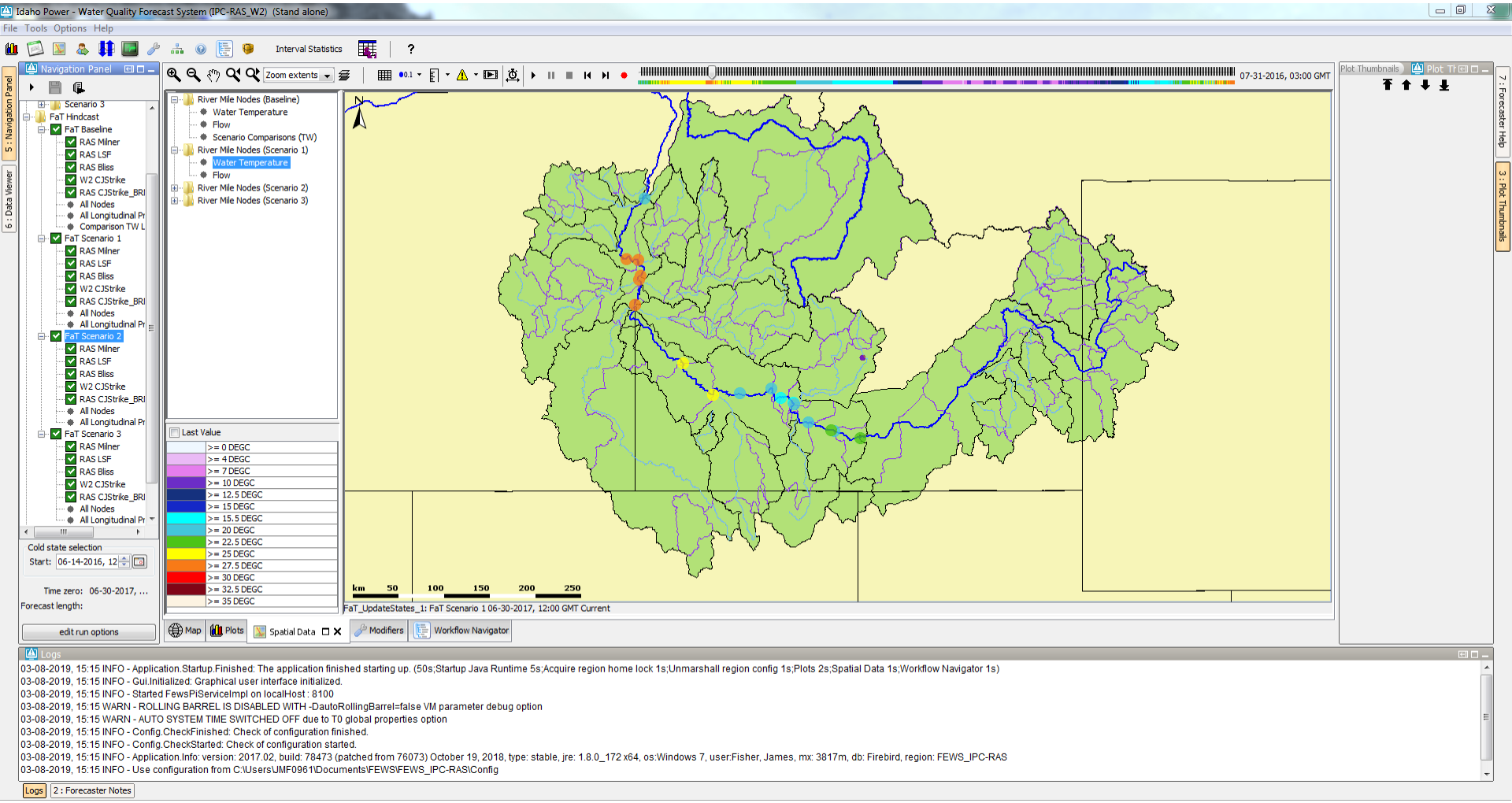
Flow and Temperature model

- Models
  - CE-QUAL W2 reservoir model at CJ Strike Dam
  - 4 HEC-RAS 1D models covering 330 River miles
  - FEWS output feeds into CE-QUAL W2 reservoir at BRN Dam
- Input Data
  - 1-hr temporal resolution
  - Network of 'Synthetic' weather stations derived from historic gridded WRF-NAM outputs
  - Observed flow and temperature at key locations (2016-2018)
    - Low-flow year in 2016
    - High-flow years in 2017 and 2018
- **Primary purpose:**
  - To better understand the water temperature drivers in the Mid-Snake River and their respective sensitivity
  - Understand the impacts of climate variability on future water temperature

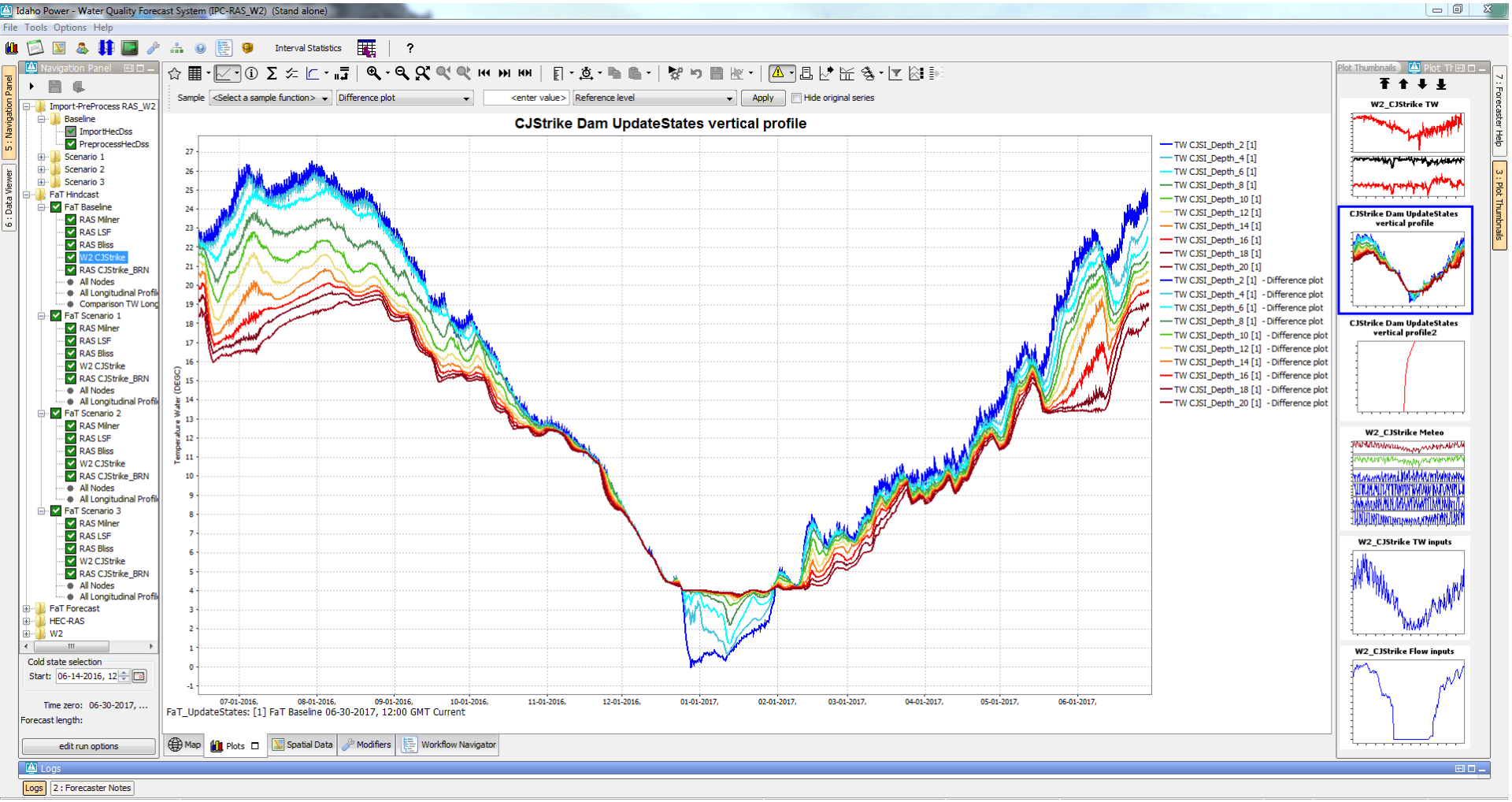
Water Quality Research Group
CE-QUAL-W2 Hydrodynamic and Water Quality Model

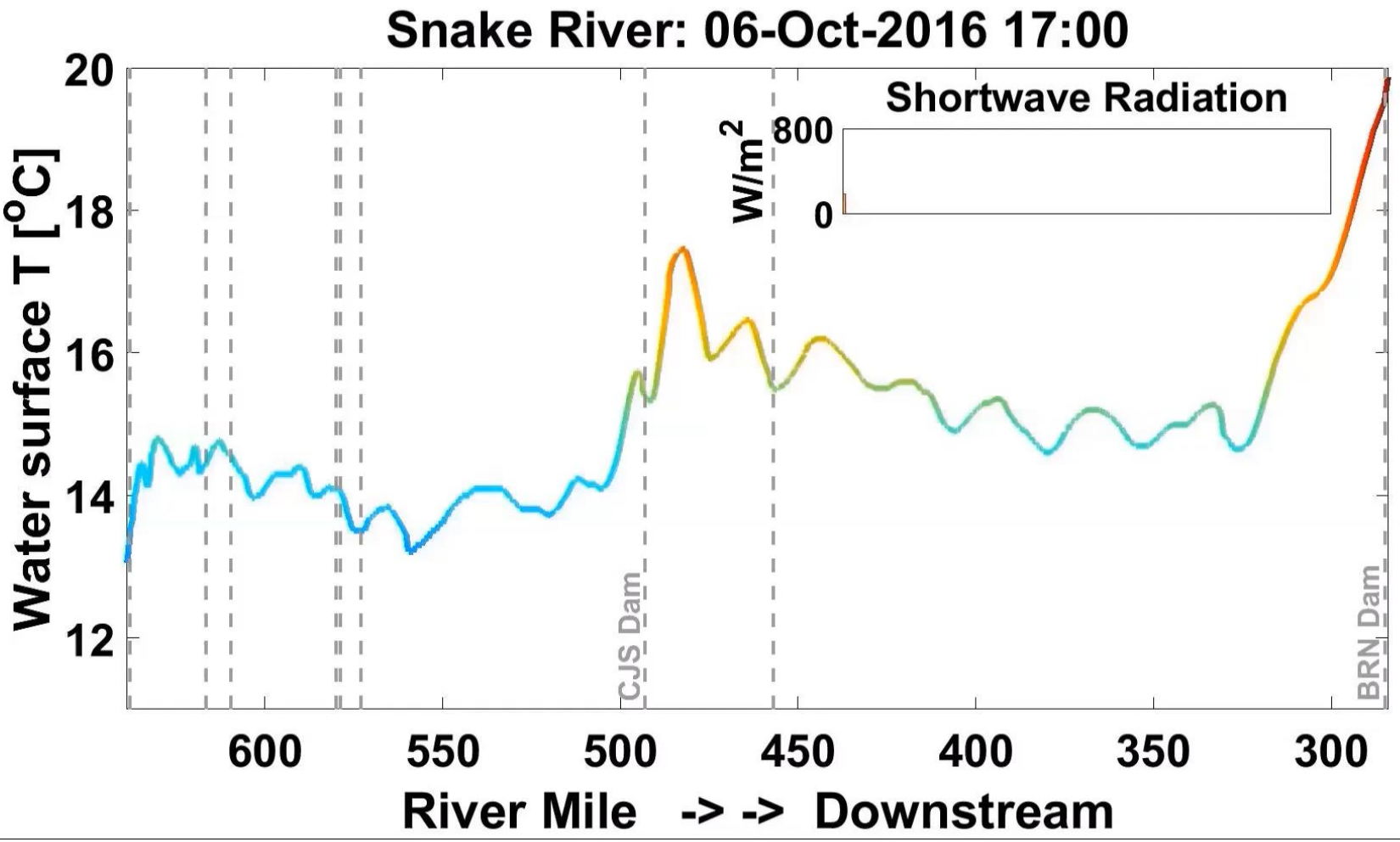
HEC-RAS

Spatial plot



CJ Strike Vertical Temperature Profile




Snake River: 06-Oct-2016 17:00
Water surface T [°C]
20
18
16
14
12
Shortwave Radiation
W/m2
800
0
CJS Dam
BRN Dam
600
550
500
450
400
350
300
River Mile -> -> Downstream

QUESTIONS/COMMENTS ?