Archive and Verification Efforts at BPA

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BPA and the Columbia River Basin

- BPA markets power for the Federal Columbia River Power System (FCRPS)

- Model 124 separate watersheds and provide official short-term forecasts for 37 locations

- Streamflow forecasts used directly by multiple BPA internal groups for power planning.


Columbia River Basin

CRB system

Natural Flows Comparison at The Dalles

January-July Volumes
2011: 142.6 maf
2012: 129.4 maf
2013: 97.7 maf
2014: 108.1 maf
2015: 83.7 maf
2016: 97.6 maf
Mean: 101.4 maf (1981-2010)

- Snowmelt driven system
- Significant annual variability in seasonal runoff volume
- System is storage limited
- Forecast assessment and verification are essential tools
    - Forecast product improvement
    - Model validation
    - Power market-based decisions
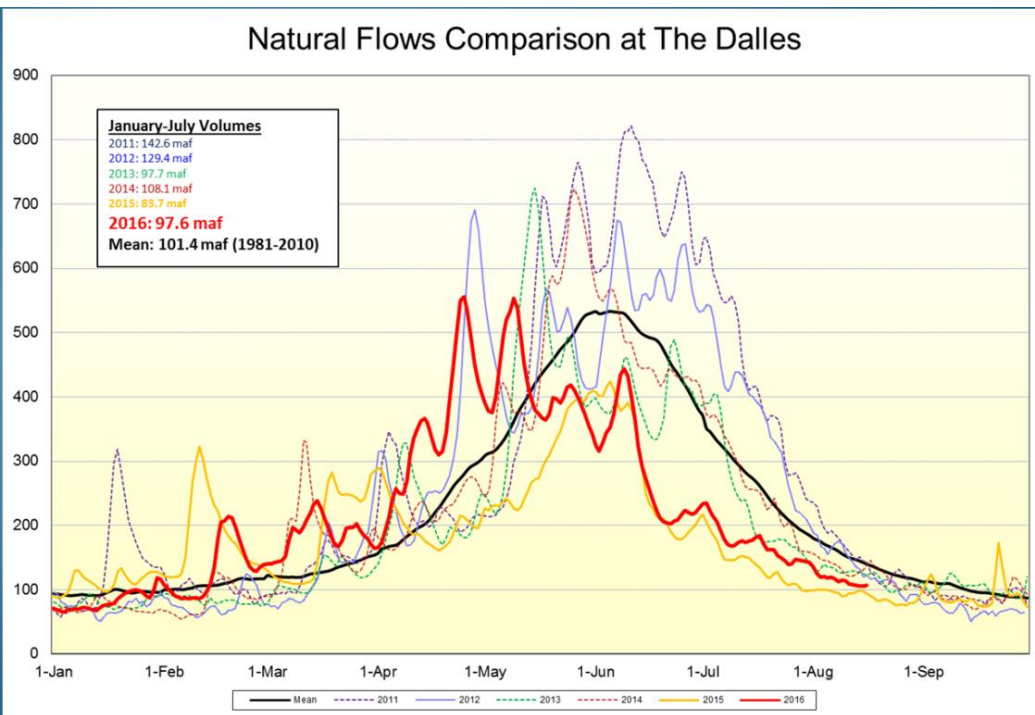
Purpose

- ## Data Archive
  - ### Foundation for verification purposes
  - ### A learning tool
    - Hindcasting specific events
    - Storm-type classification

- ## Verification
  - ### Within group
    - Forecast assessment
    - Identification of biases
  - ### Other users
    - Short term power planning; Marketers

Streamflow Forecasts

Observation Data

Data Archive

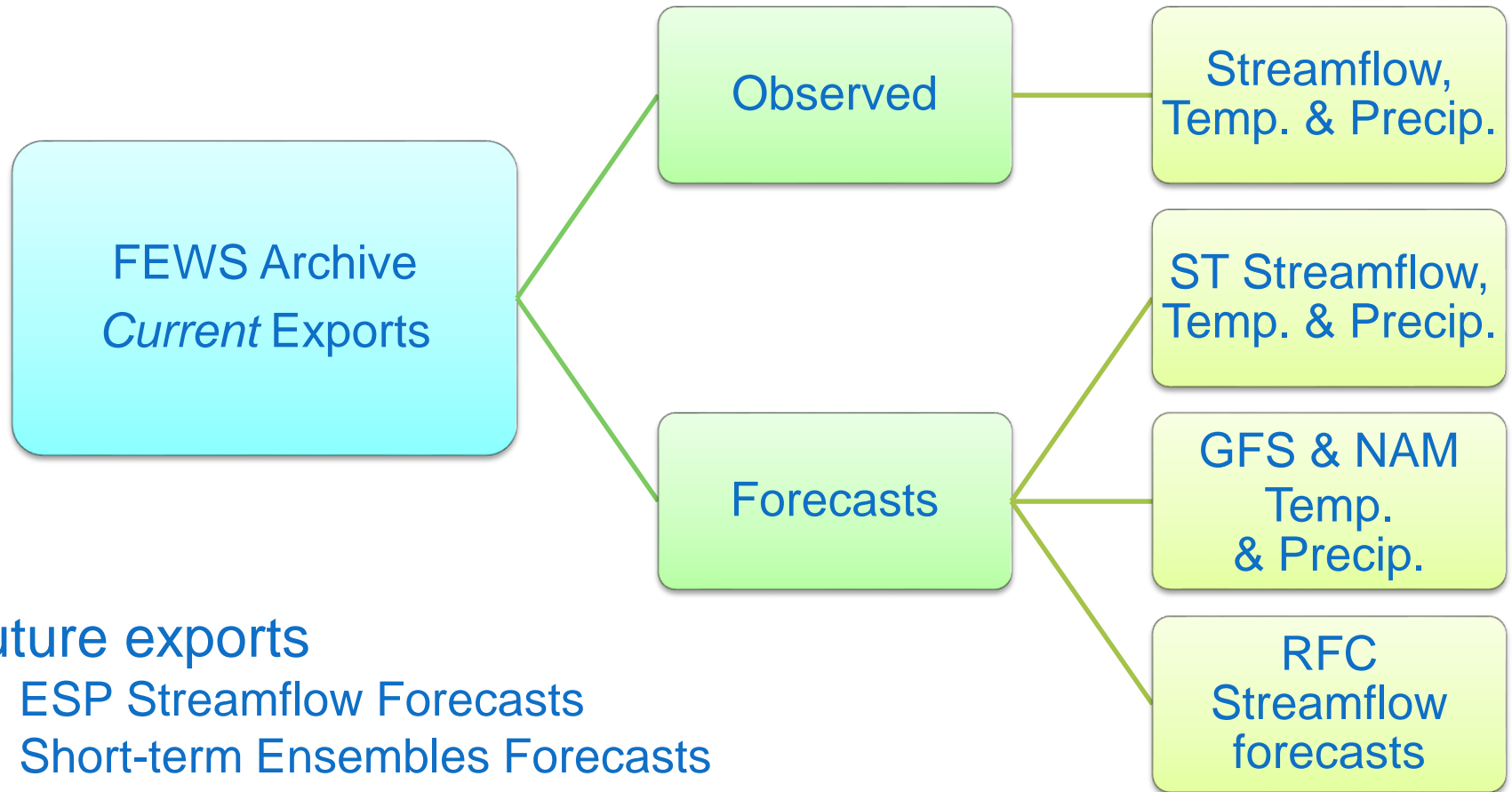Verification

Streamflow Forecasts
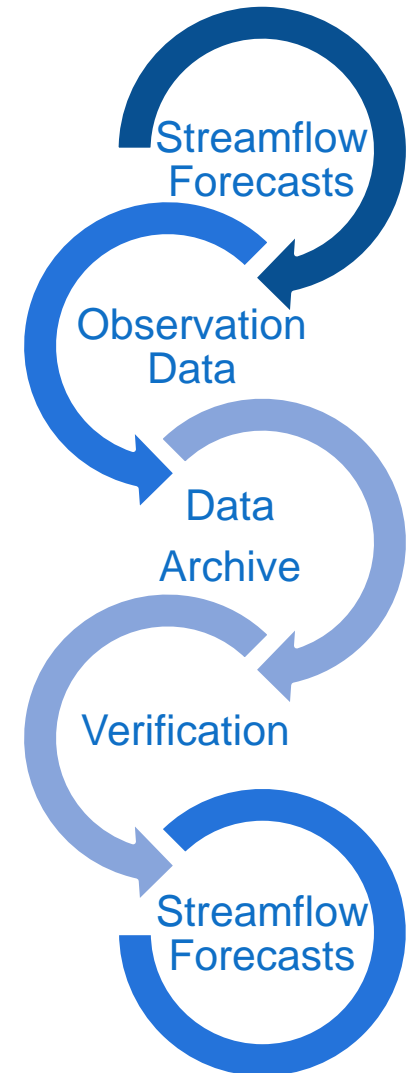
Old method of archiving

- Data repository not centralized
  - Flat files in isolated directory structure
- No easy way to retrieve or analyze data
  - Stored as PI-XML files
- Numerous data types and naming conventions
  - ModuleInstanceIds

Data Type	Observed Variable	Observed Variable Type	Observed Source	Observed Time Step
Observed	Precipitation	Mean-Areal	BPA	6-hour
Observed	Precipitation	Point	BPA	1-hour
Forecast	Water-Supply-Vol.	-	BPA	Jan-Jul
Forecast	Water-Supply-Vol.	-	BPA	Apr-Jul
Forecast	Water-Supply-Vol.	-	BPA	Apr-Aug
Observed	Precipitation	Point	BPA	6-hour
Observed	Precipitation	Point	BPA	daily
Observed	Precipitation	Point	BPA	1-hour
Forecast	Streamflow	-	BPA	6-hour
Forecast	Streamflow	-	BPA	1-hour
Forecast	Water-Supply-Vol.	-	BCHydro	Jan-Jul
Forecast	Water-Supply-Vol.	-	BCHydro	Apr-Aug
Forecast	Streamflow	-	NWRFC	6-hour
Observed	Temperature	Point	BPA	6-hour
Observed	SWE	Mean-Areal	BPA	6-hour
Observed	SWE	Point	NRCS	Daily
Forecast	Streamflow	-	GEFS	6-hour
Forecast	SWE	Mean-Areal	BPA	6-hour
Forecast	Freezing-Level	Grid	BPA	daily
Forecast	Streamflow	-	BPA	6-hour
Forecast	Streamflow	-	BPA	daily
Forecast	Streamflow	-	BPA	hydsim
Forecast	Streamflow	-	NWRFC	6-hour
Forecast	Water-Supply-Vol.	-	BPA	Apr-Sep
Forecast	Water-Supply-Vol.	-	BPA	May-Jul
Forecast	Water-Supply-Vol.	-	BPA	May-Sep
Forecast	Water-Supply-Vol.	-	BPA	wateryear
Observed	Precipitation	Point	BPA	6-hour
Observed	Precipitation	Point	BPA	daily
Observed	Temperature	Mean-Areal	BPA	6-hour
Observed	Temperature	Point	BPA	1-hour
Forecast	Water-Supply-Vol.	-	NWRFC	Jan-Jul
Forecast	Water-Supply-Vol.	-	NWRFC	Apr-Jul
Forecast	Water-Supply-Vol.	-	NWRFC	Apr-Aug
Forecast	Water-Supply-Vol.	-	USACE	Jan-Jul
Forecast	Water-Supply-Vol.	-	USACE	Apr-Jul
Forecast	Water-Supply-Vol.	-	USACE	May-Jul
Forecast	Water-Supply-Vol.	-	USBR	Jan-Jul
Forecast	Water-Supply-Vol.	-	USBR	Apr-Aug
Forecast	Water-Supply-Vol.	-	USBR	May-Jul

FEWS Open Archive

FEWS Archive
Current Exports

Observed

Streamflow, Temp. & Precip.

Forecasts

ST Streamflow, Temp. & Precip.

GFS & NAM Temp. & Precip.

RFC Streamflow forecasts

- Future exports
  - ESP Streamflow Forecasts
  - Short-term Ensembles Forecasts
    - Precip., Temp., & Streamflow

FEWS archive challenges

- Accessing data in FEWS archive primarily relies on tomcat and PI service
- Can only view archived data in FEWS in an SA
- Difficulty in setting up and testing
  - Certain files in tomcat directory need to be created by the user in a very specific way
  - PI service test page is sometimes unresponsive
  - Errors from PI rest service not very helpful
  - Retrieves empty data when there's actual data in the NetCDF files

FEWS archive challenges

EVS efforts

- EVS project file set up for verifying streamflow, precip, and temperature forecasts
- EVS advantages
  - Can get data from FEWS archive
  - Can run headless
  - Grouping of forecasts points (verification units)
  - MANY ensemble stats to choose from
  - Bin data and set thresholds
  - Many file input and output types
 - Excellent documentation and support

EVS challenges

- EVS can't display more than one forecast source at a time
- Where to put EVS outputs?
- How to use EVS operationally?
- Difficult to use with PI service
- EVS graphics could be improved

Mean Error of the ensemble average by forecast lead time.
SELI1.Streamflow.clearwater
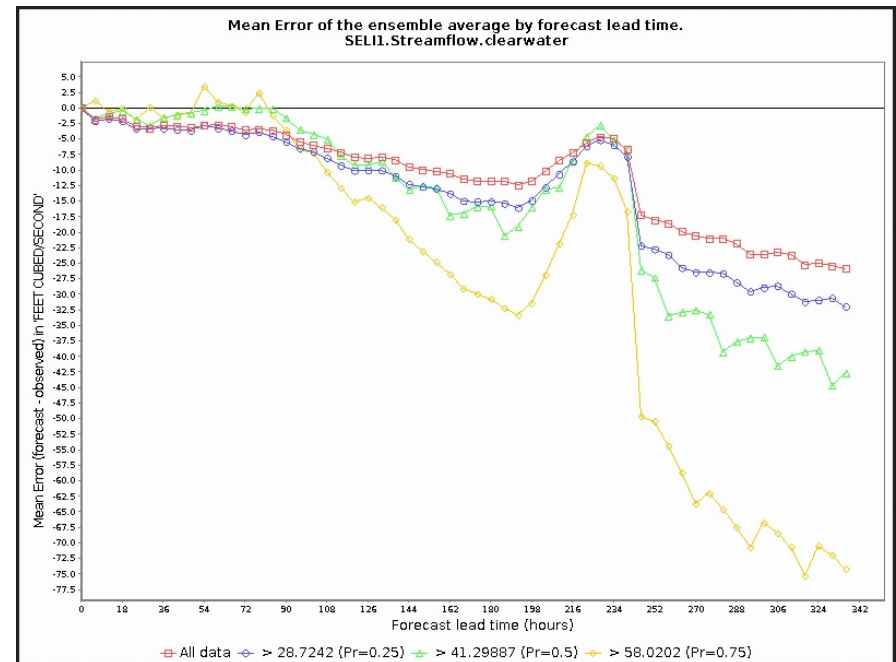
Current Archive Data Display

- Using Python library called 'Bokeh' to display data from FEWS archive

- Currently grabbing data directly from netCDF files. No PI service used yet…

- Allows user to interact with dropdown menus and plots
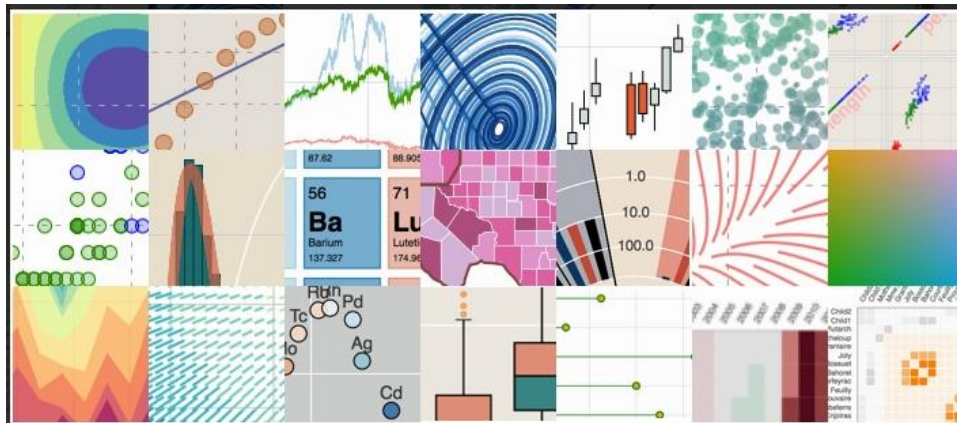
Preliminary Bokeh Graphics
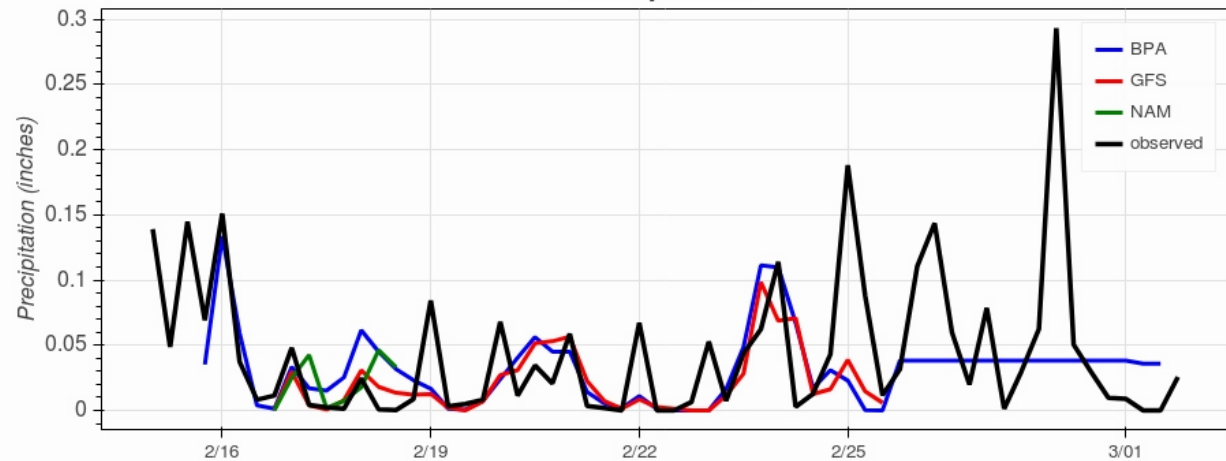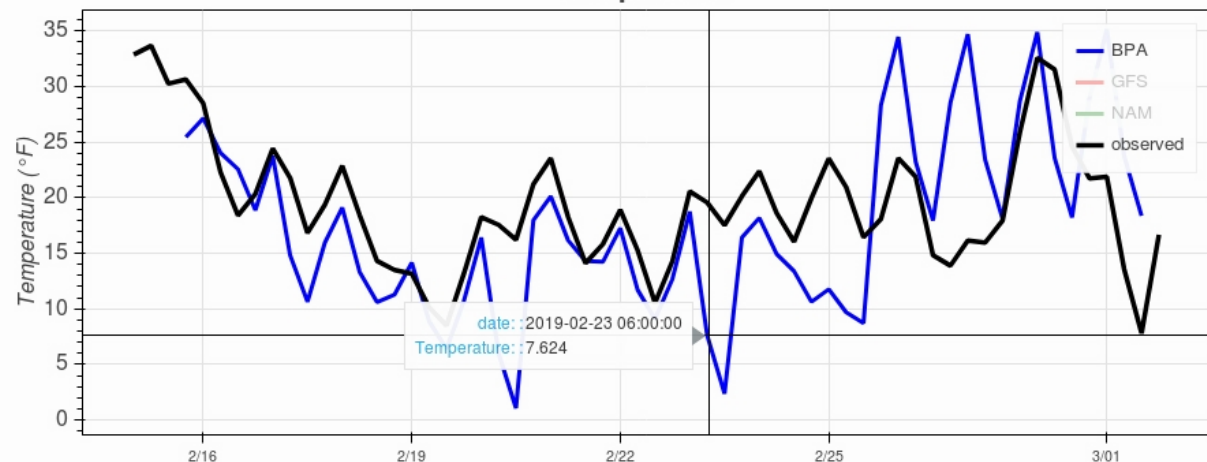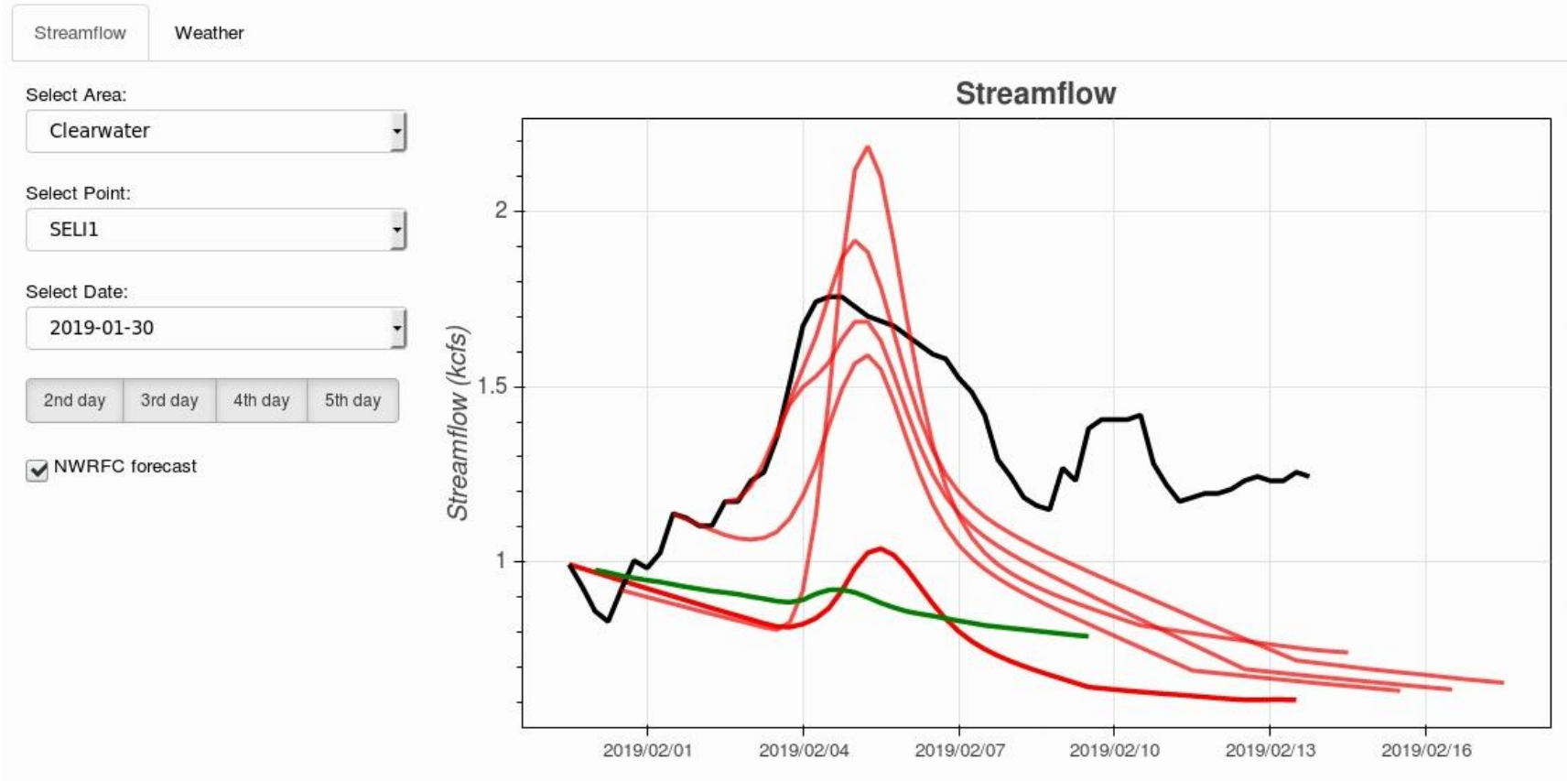
Preliminary Bokeh Graphics

Application needs

- Immediate
  - Tomcat and PI service set-up improvements (better install scripts?)
  - Reliable PI service
  - Upgraded archive and EVS statistics graphical displays
  - Central database or archive for EVS statistical results
- Our future visions
  - Group mechanism to assess multiple events
  - On the fly stats calculation for "event-type" scenarios
  - Water coach?

Questions or comments