“ For every complex problem,
there is a solution that is

Simple,
Neat,
And
Wrong.”

“H. L. Menken”

CBRFC AHPS PROJECT

A cooperative effort between:

Goals

Introduce probabilistic 14 day meteorological forecasts (ensembles) into a river forecast system.

Capture and display the uncertainty.

Verify the process.

Method

Medium Range Forecast Model

Downscale to Model Variables

Mean Areal Temperature and Precipitation Ensembles

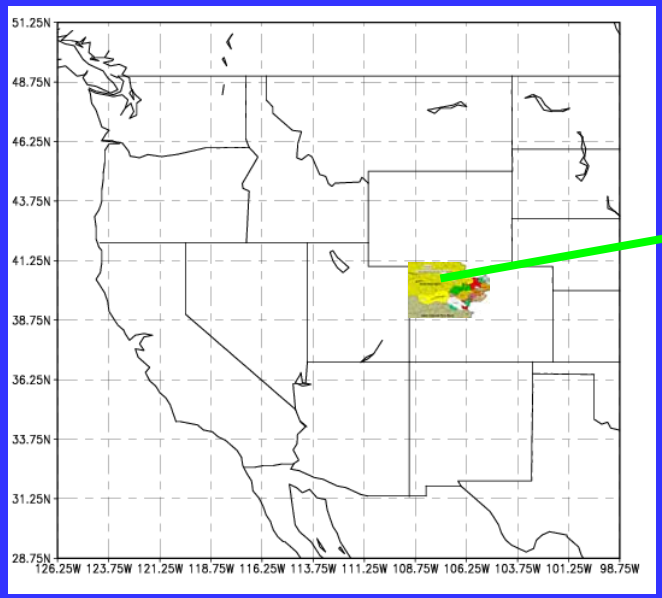
ESP Model

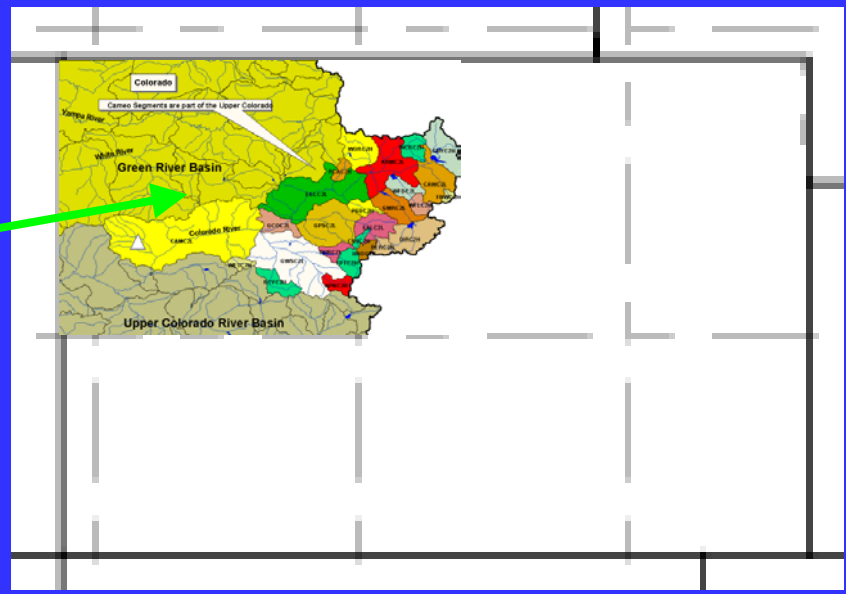
Probabilistic River Forecasts

Medium Range Forecast (MRF) Model

- Global Meteorological Model
- Many Atmospheric Variables
- Frozen Version
- Run Daily at CDC
- ~70km Spatial Resolution

MRF Spatial Resolution

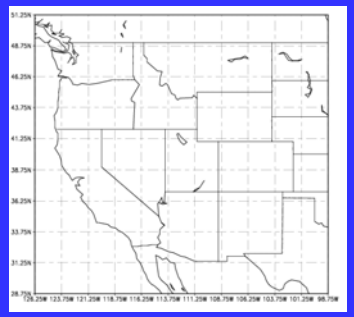


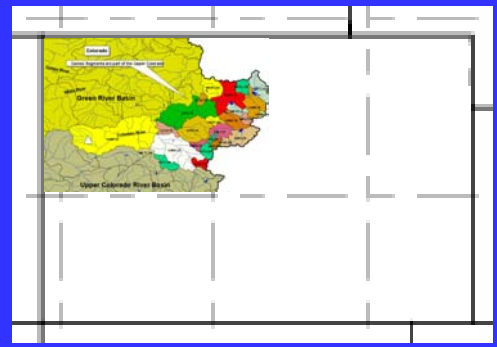


WAY TOO LARGE!

Need to Relate to Basin…

Downscaling





MRF Variables:

- 2m air temp
- Precipitation
- 700mb Relative Humidity
- Sea Level Pressure
- 10m Vector Wind
- Total Column Precipitable Water

Basin Scale Variables:

- Mean Areal Temperature
- Mean Areal Precipitation

Downscaling Method

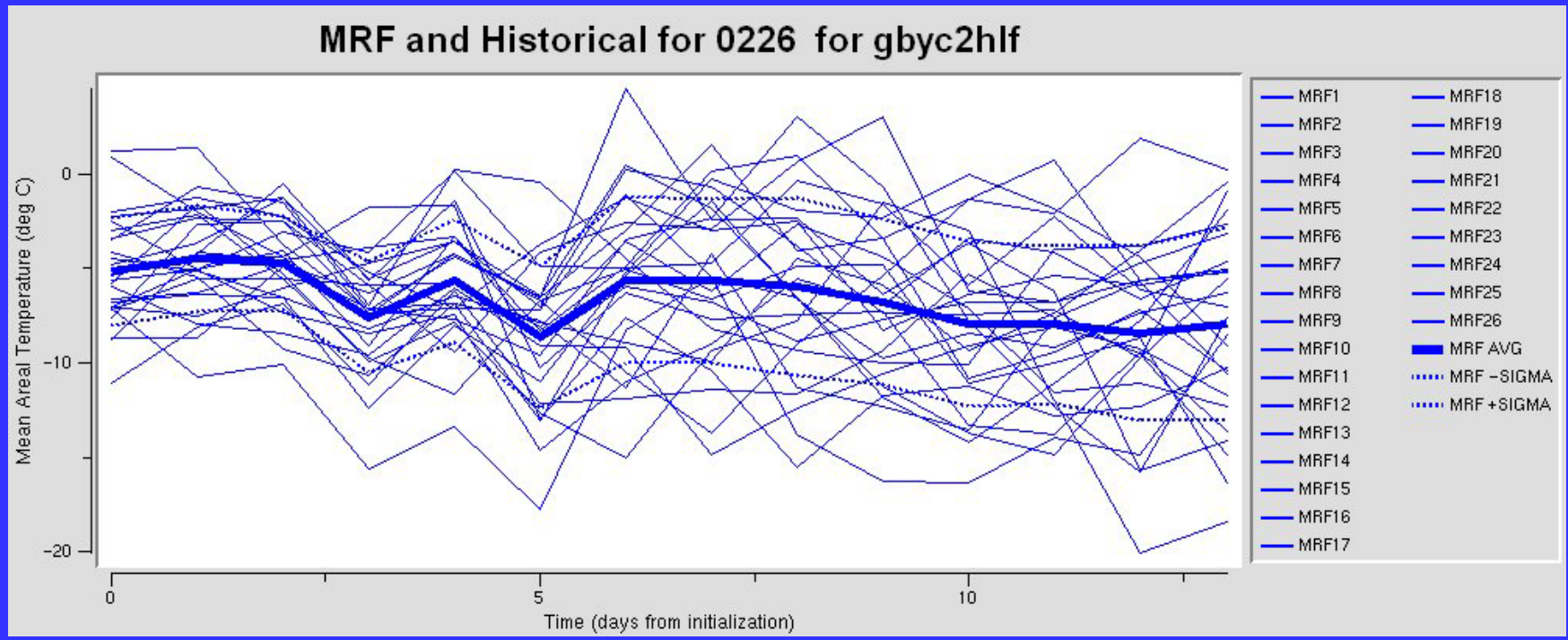
1. Relates historical MRF scale variable to historical basin scale variables through multivariate linear regression equations. For example:

   Basin MAP = a_1(MRF Precipitation) + a_2(MRF wind) + …

2. Equations developed in (1) are applied to future MRF forecasts to produce forecasts of basin scale variables.

3. Multiple values at a particular time step are generated to create ensembles.

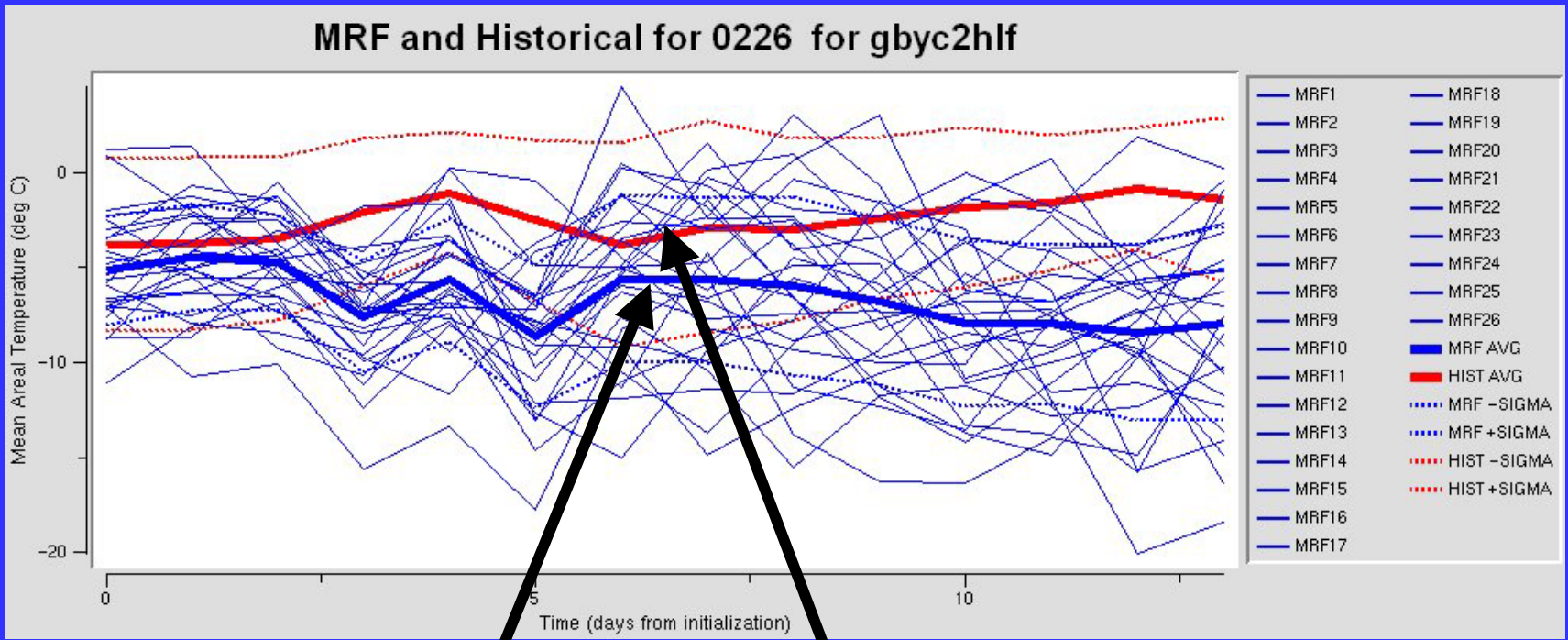
Downscaling Results



Example:

26 Ensembles of MATs for Each Sub-Basin

Downscaling Results



MRF is colder than normal in this case.

ESP Method

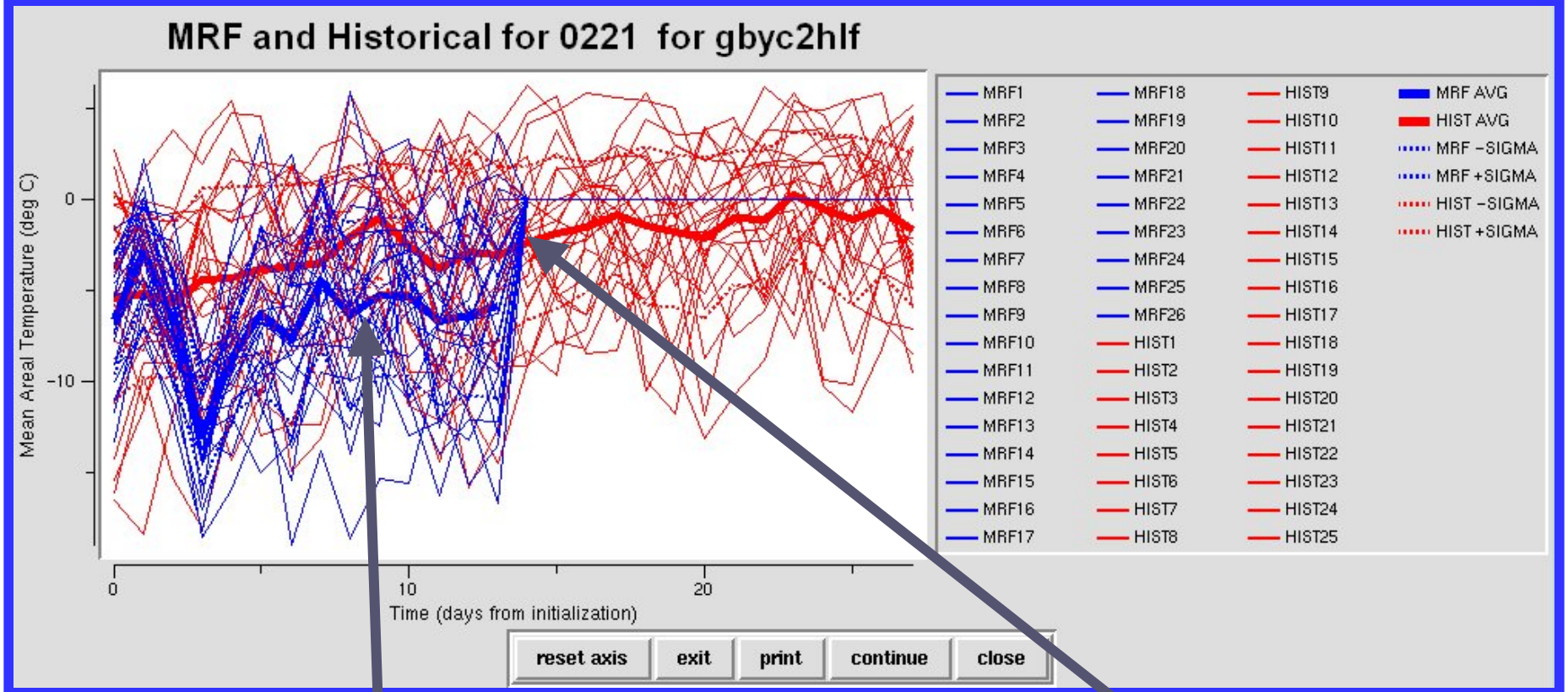
ESP uses initial states from the operational hydrological model along with ensembles of MAT/MAP as input.

Each ensemble is ran through the model.

Ensembles of streamflow are produced.

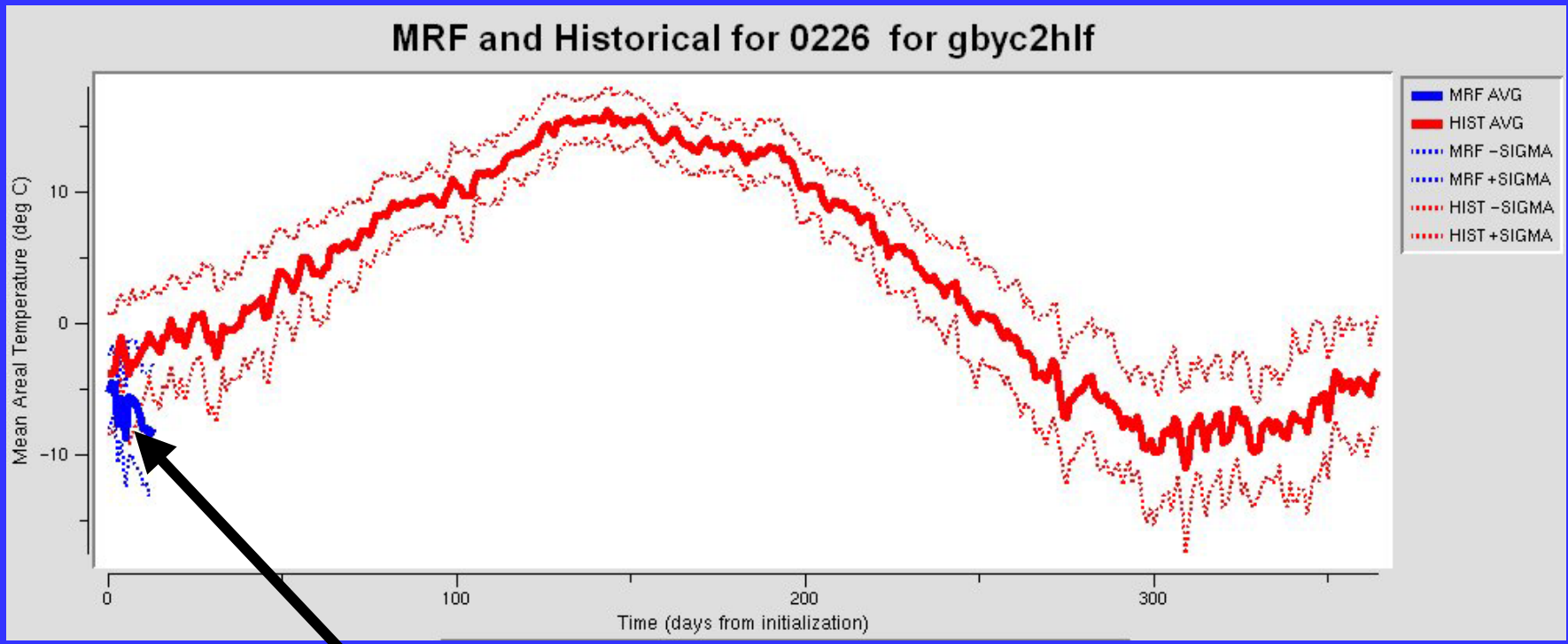
Ensemble distributions are analyzed and turned into probabilistic forecasts.

Input into ESP



MRF derived MAT/MAPs are attached to historical years ("ensembles") and 'fed' to ESP.

Input into ESP



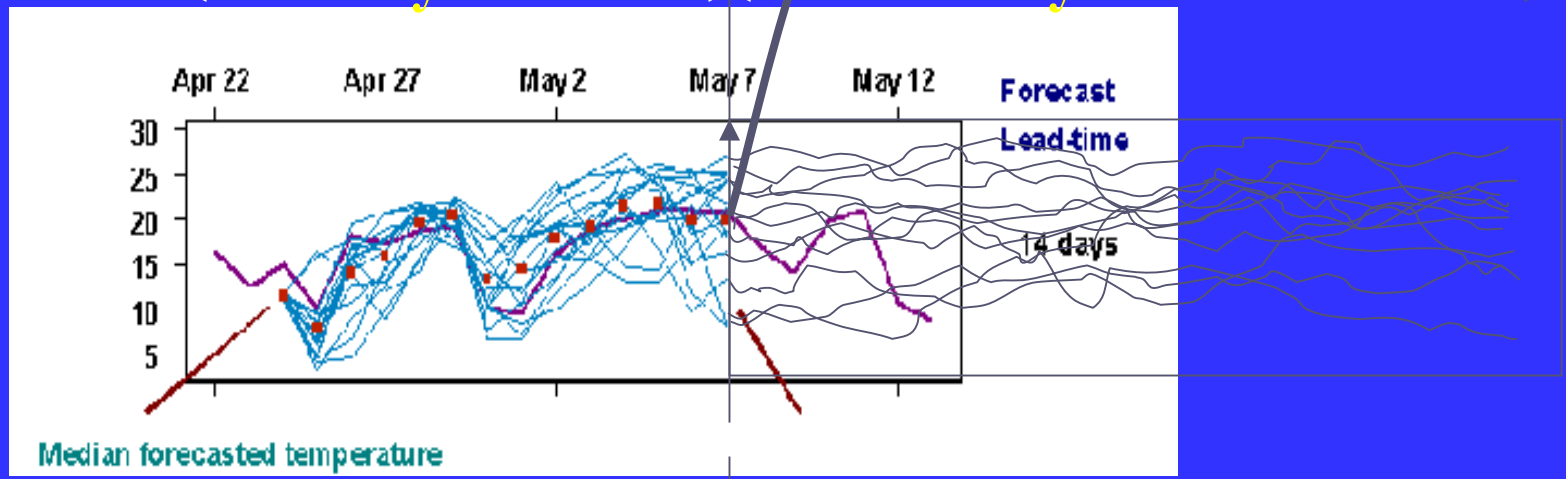
MRF derived MAT/MAPs related to the entire year of historical ensembles.

Schematic of Using Ensembles from MRF(day 1-14) As Input to ESP

Blending/Attachment

Days 1-14

Days 15-365

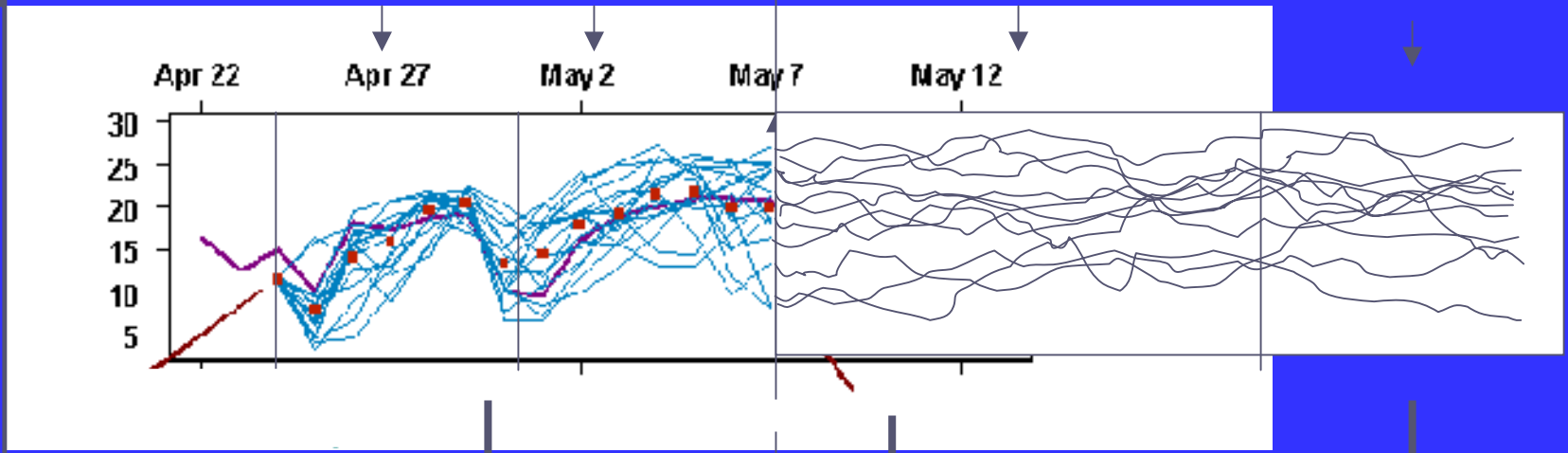


Ensembles From The 'Frozen' MRF

Ensembles From Historical Data

Information We Will Verify

Week 1 | Week 2 | Week 3 – 4 | APR-JUL

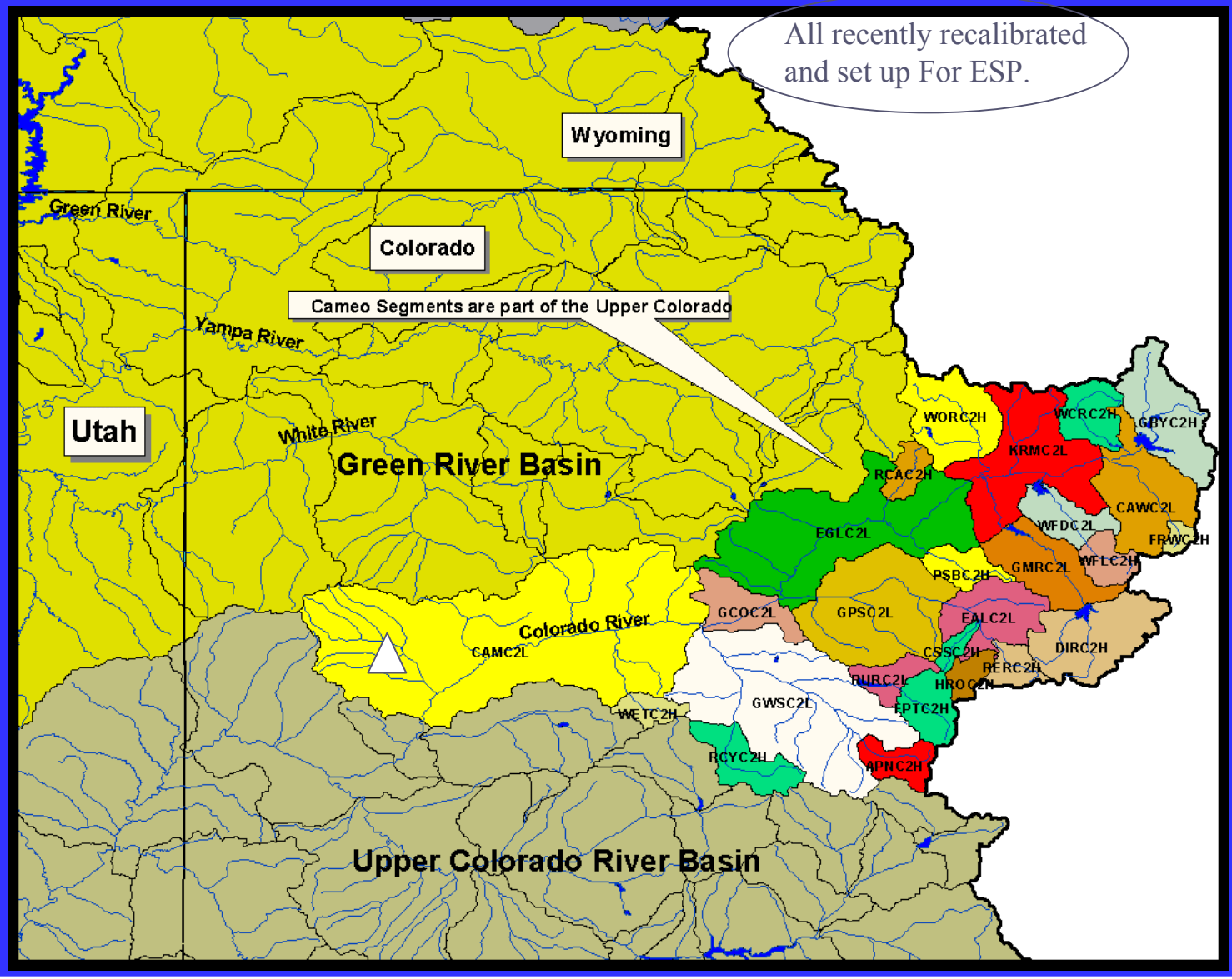


Instantaneous Flow:
6 hour time step
Volume
Peak
Various Probabilities

Volume
Peak
Various Probabilities

Seasonal Volume
Seasonal Peak
Various Probabilities

Project Area: 27 Segments Above Cameo, Colorado River



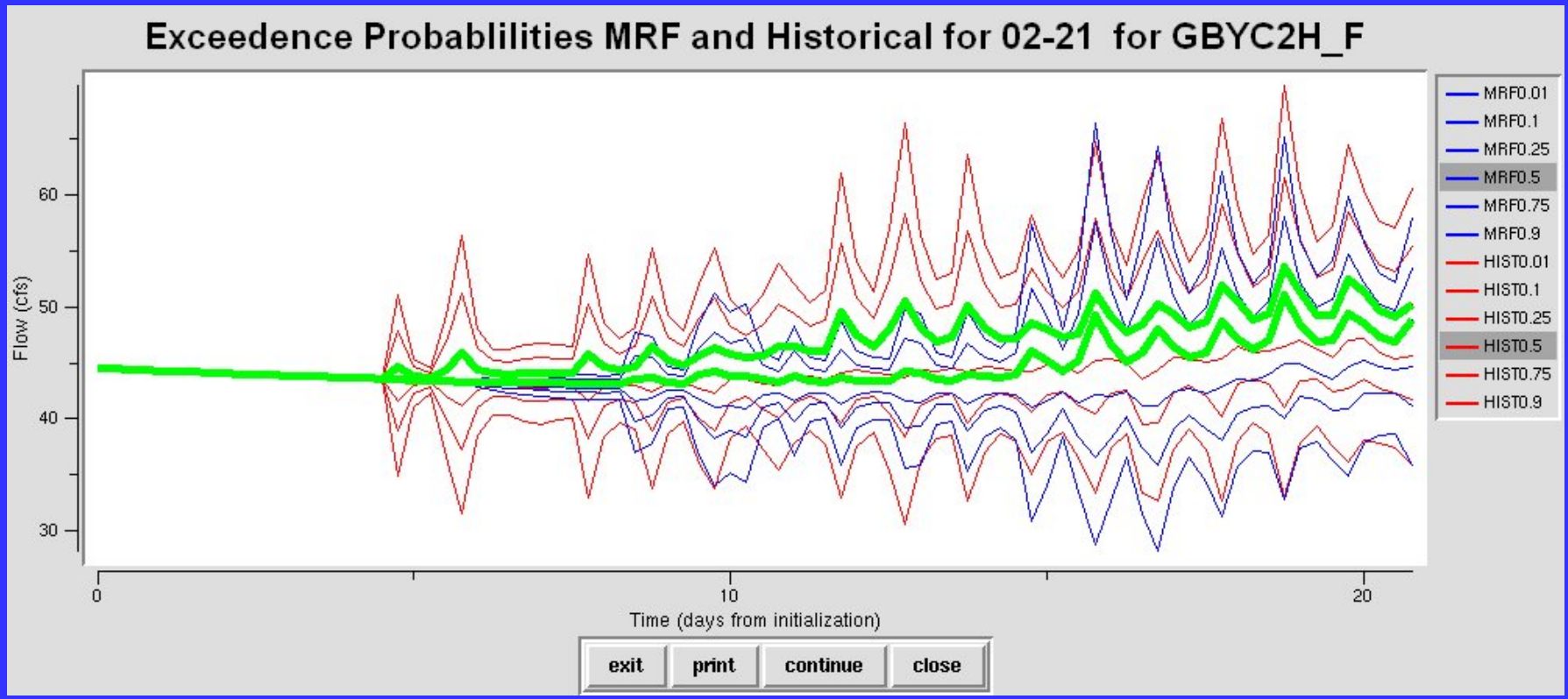
RUN ESP – EACH BASIN – TWO WAYS – EACH DAY

	Week 1	Week 2	Weeks 3-52
1	HISTORICAL ENSEMBLES OF MAPS/MATS – NOT WEIGHTED BY CPC FORECASTS		
2	MRF ENSEMBLES OF MAPS/MATS	HISTORICAL ENSEMBLES OF MAPS/MATS – NOT WEIGHTED BY CPC FORECASTS	

Future Plans

3	MRF ENSEMBLES OF MAPS/MATS	WxGEN ENSEMBLES OF MAPS/MATS – WEIGHTED BY DOWNSCALED CPC FORECASTS	
4	1-5 day HPC	1-10 day TA CPC	HISTORICAL ENSEMBLES OF MAPS/MATS – WEIGHTED BY CPC FORECASTS
5	MRF ENSEMBLES OF MAPS/MATS	HISTORICAL ENSEMBLES OF MAPS/MATS – WEIGHTED BY CPC FORECASTS	

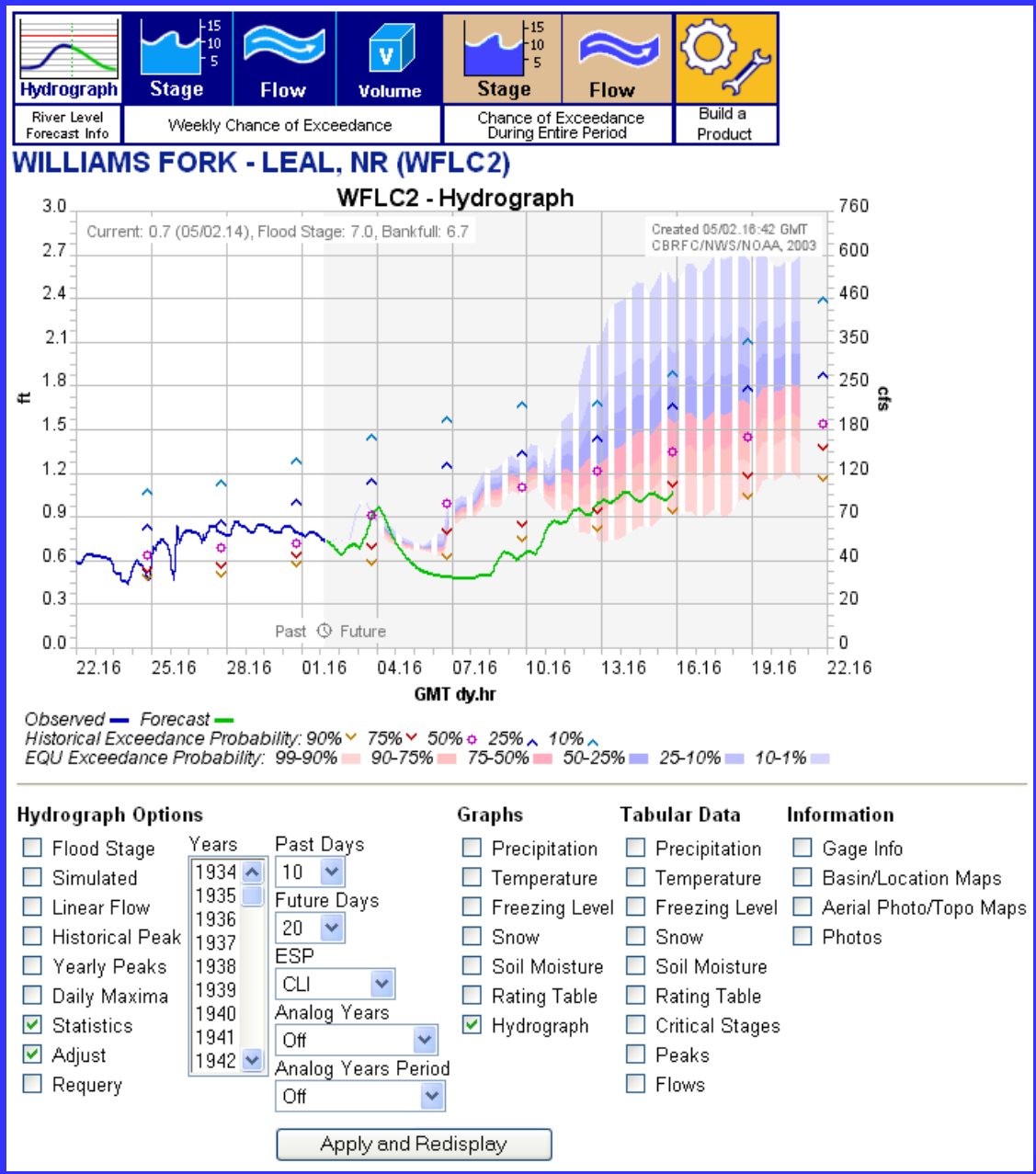
ESP flow time series



Six hour instantaneous flow values at sIX probability levels are saved.

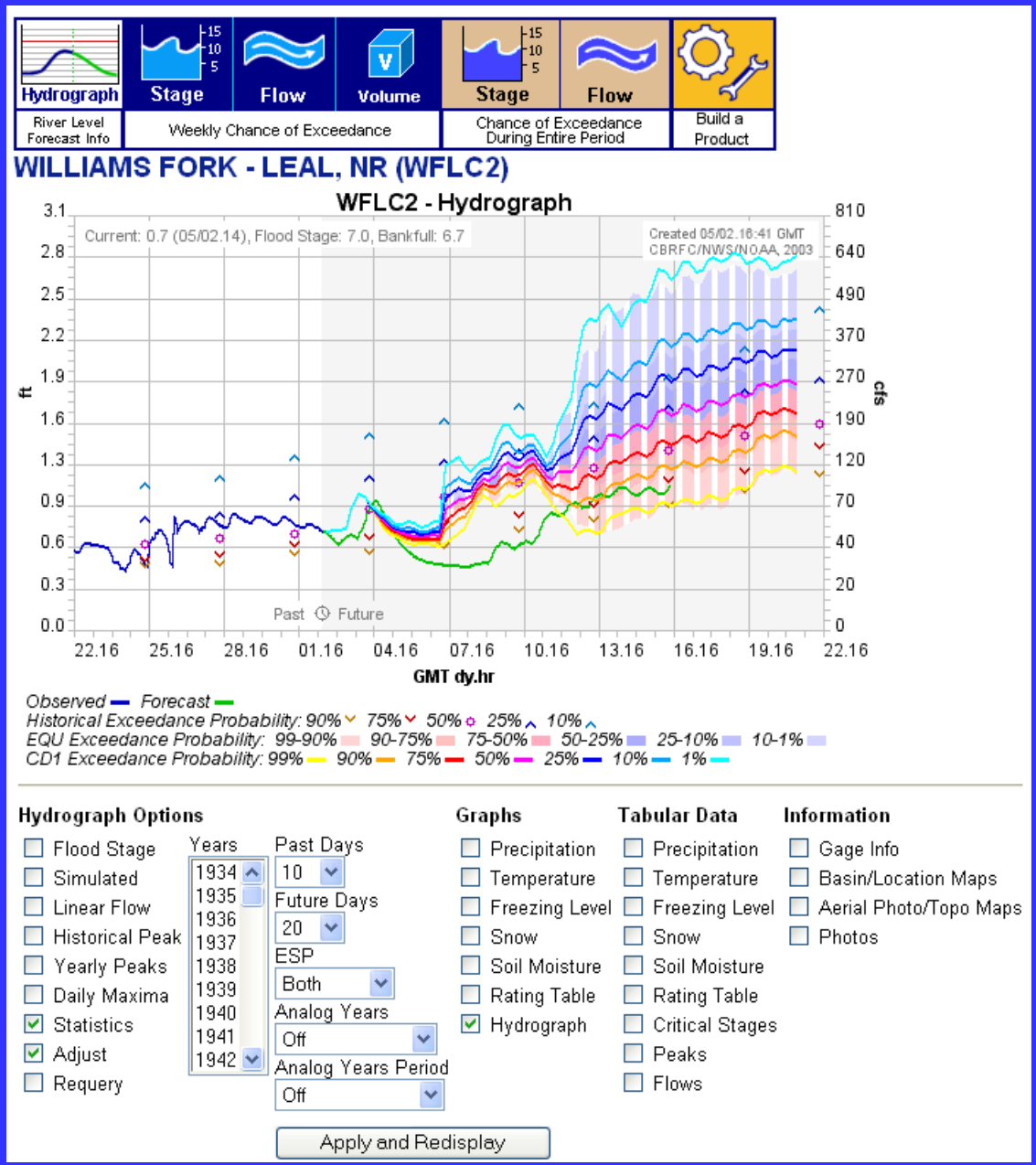
Web Page Example

Probabilities from ESP (shaded) Using Historical MAPs and MAPs Equally Weighted Plotted with Deterministic Forecast and Historical Exceedance Values

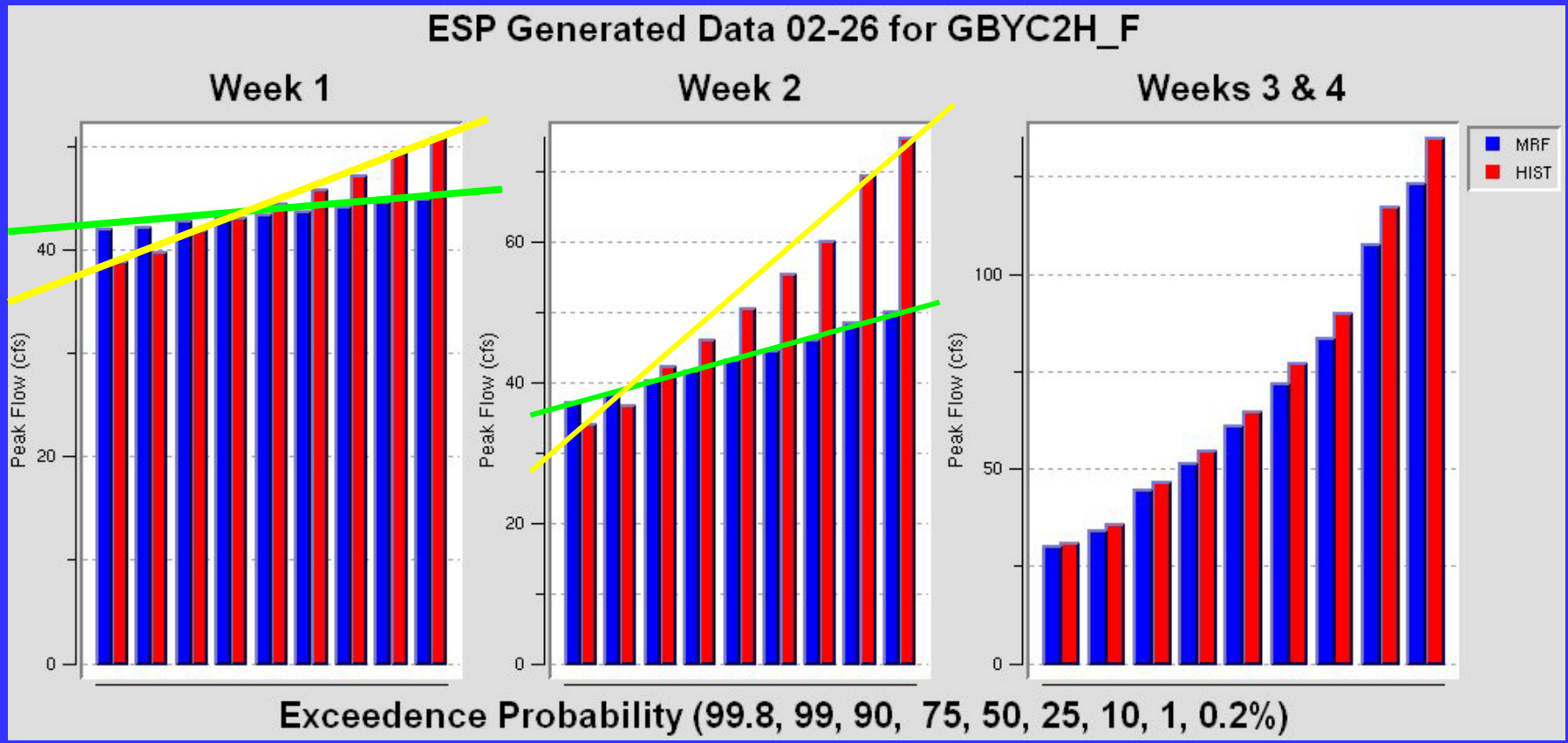


Web Page Example

Probabilities from ESP (shaded) Using Historical MAPs and MAPs Equally Weighted and ESP (lines) Using Maps And Mats Derived from The MRF Ensembles Plotted with Deterministic Forecast and Historical Exceedance Values

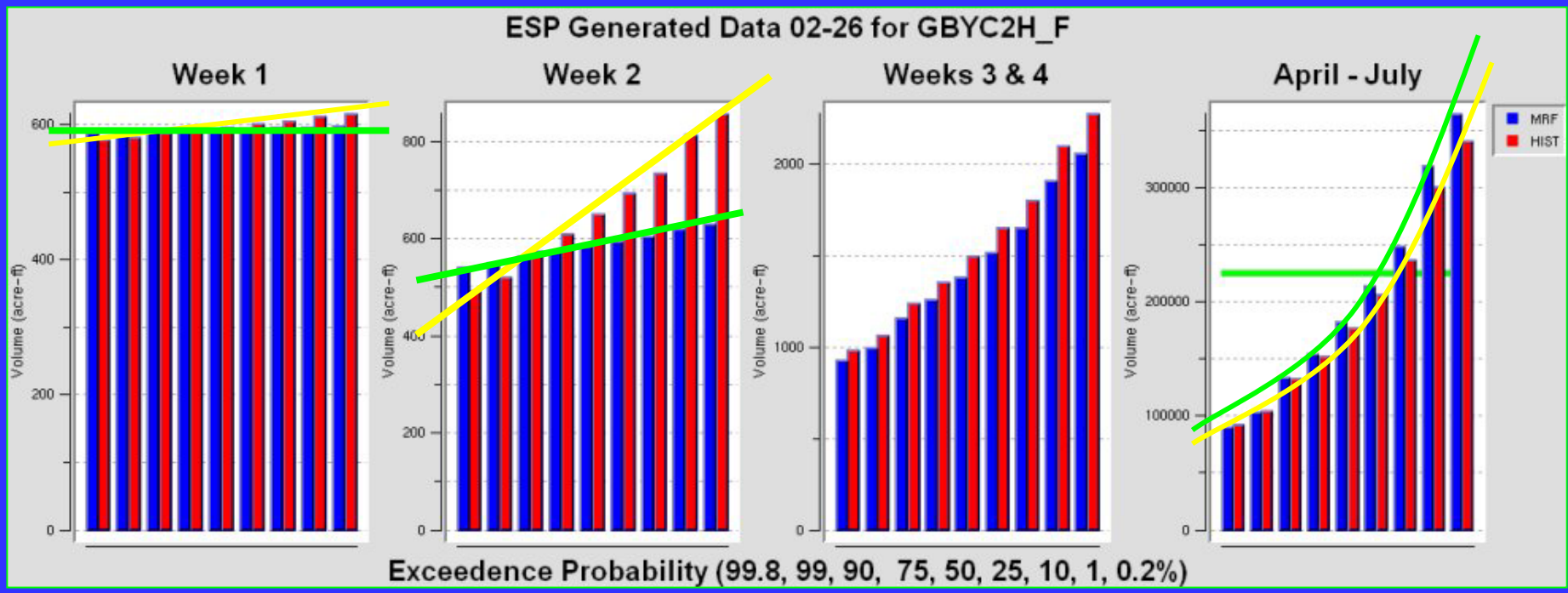


ESP peak flow



Smaller peaks because MRF is colder for first 14 days causes less melt.

ESP volumes



Smaller volumes through week 4 due to "banking" of water in colder than normal period leads to larger April – July volume.

Future Plans

Use Statistical Weather/Climate GeneratorIn Lieu of Historical Ensembles

Use Experimental Technique to Downscale CPC Forecasts/Apply to Historical and WX/Generator

Use Finer Grid MM5 Forecasts to Produce Downscaled MAPS/MATs

Investigate Downscale Errors – Lumps or Points

Information We Will Save In Relational Table-PRIME Key Fields

Location/Station ID
PEDTSEP
Type of units for analysis window
number of units for analysis window
creation date time
beginning date time or window
carryover date time
carryover group
probability distribution
weighting scheme
blend future precipitation initial weight
blend future precipitation hours of weighting
blend future precipitation final weight
blend future precipitation number of days of blending
blend future temperature initial weight
blend future temperature hours of weighting
blend future temperature final weight
blend future temperature number of days of blending historical data type
historical time step
beginning year of historical data
ending year of historical data