The Colorado Basin River Forecast Center Upper Colorado Region Annual Water Operations Conference

Water Supply Forecast

Flash Flood Forecasts

Recreational Forecasts

River Forecasts

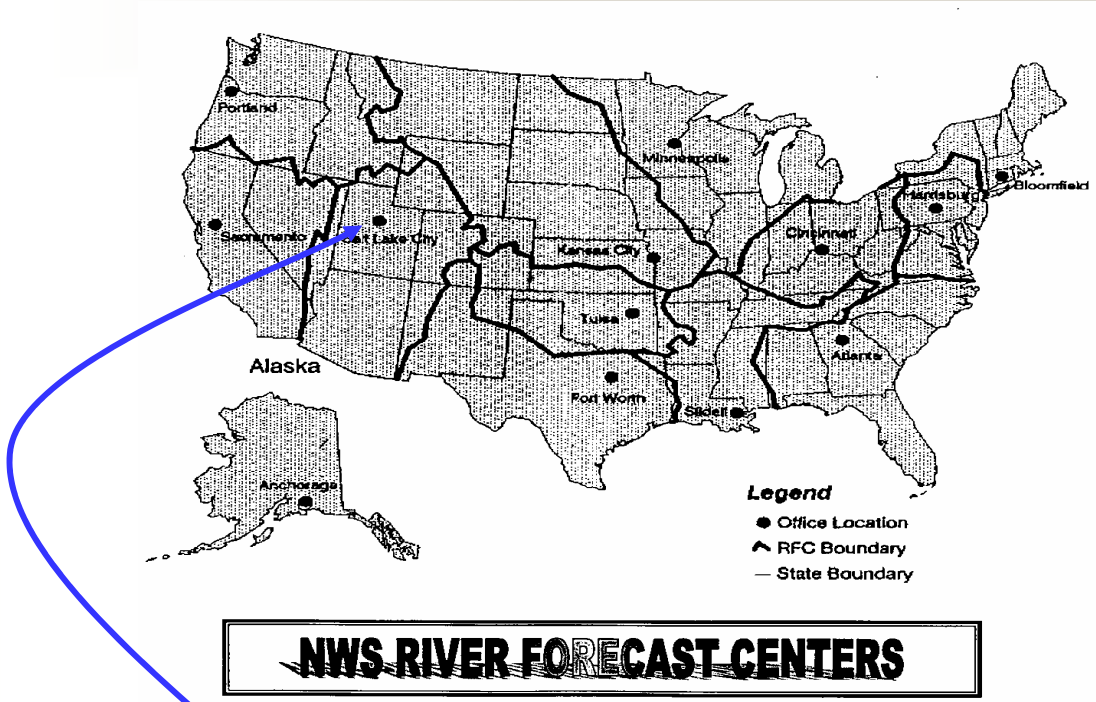
National Weather Service Salt Lake City, Utah
March 24-25, 2004

Colorado Basin
River Forecast Center

USBR-NWS Liaison

Previous: Bob Adams, Roland Springer,

Current: **Chris Cutler**



NWS RIVER FORECAST CENTERS

CBRFC AREAL STATISTICS

AREA	=	**303,450 SM (RANK 5TH)**
COUNTIES	=	**558**
STATES	=	**7**
NEXRADS	=	**16**

Two Basic Models Are Used to Forecast Streamflow

(1) Statistical Regression Models

Relates input variables such as snowpack, precipitation, climate indices to an output variable, volumetric streamflow

(2) Ensemble Streamflow Prediction

Uses historical traces of precipitation and temperature and conditions these based on current soil moisture conditions…traces can be weighted

Statistical Regression

Used since late 40's
Simple Model-Easy to Implement
Good at predicting a single variable
Breaks down in extreme years
Non-Linear capabilities
    Neural Networks
    Power Functions
    Nearest Neighbor Analogs

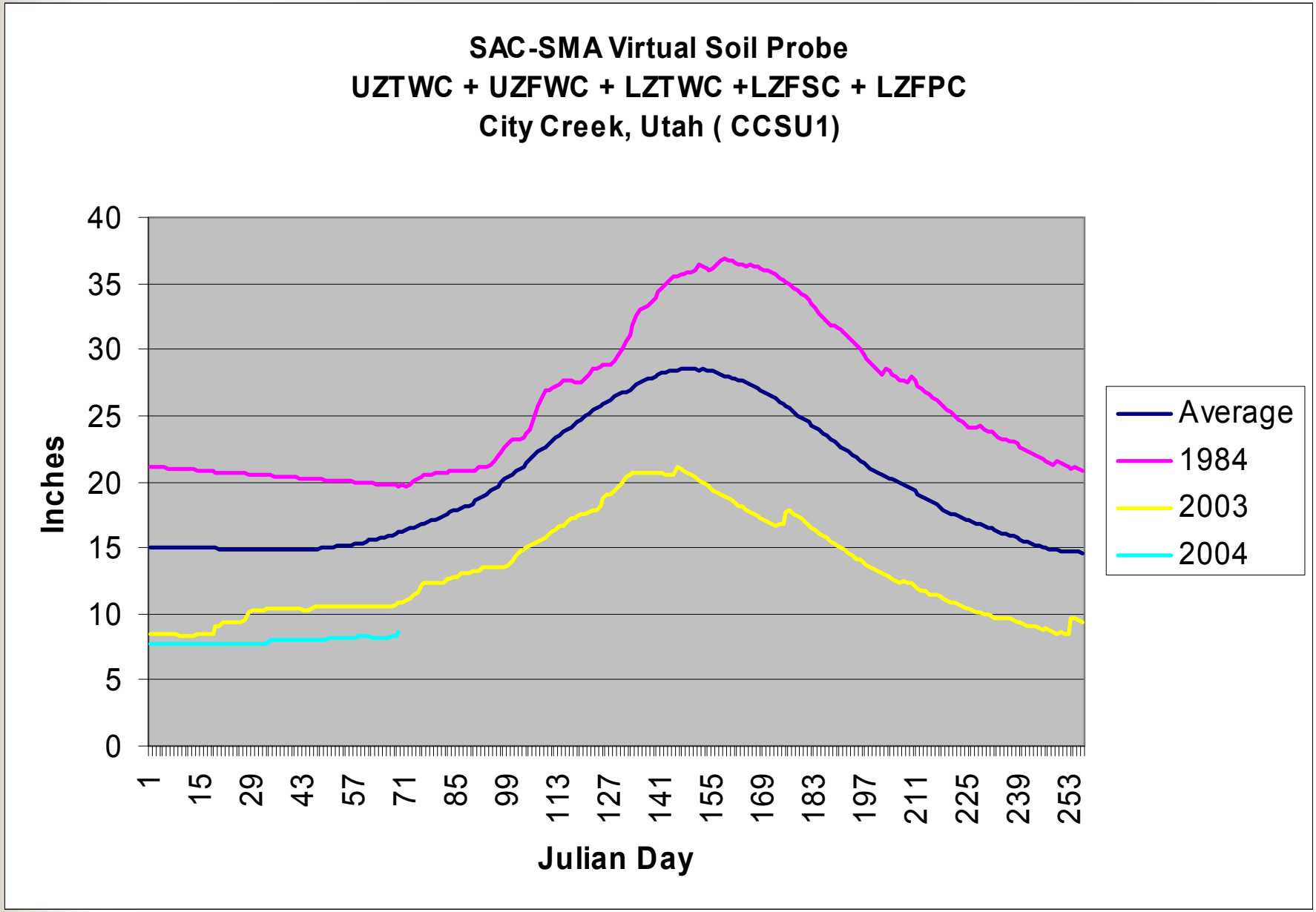
Statistical Regression

Variables used…

- snow water equivalent
- precipitation
- past streamflow
- climatological signals
  - SOI, MEI, etc

Future Variables…

- virtual soil mositure

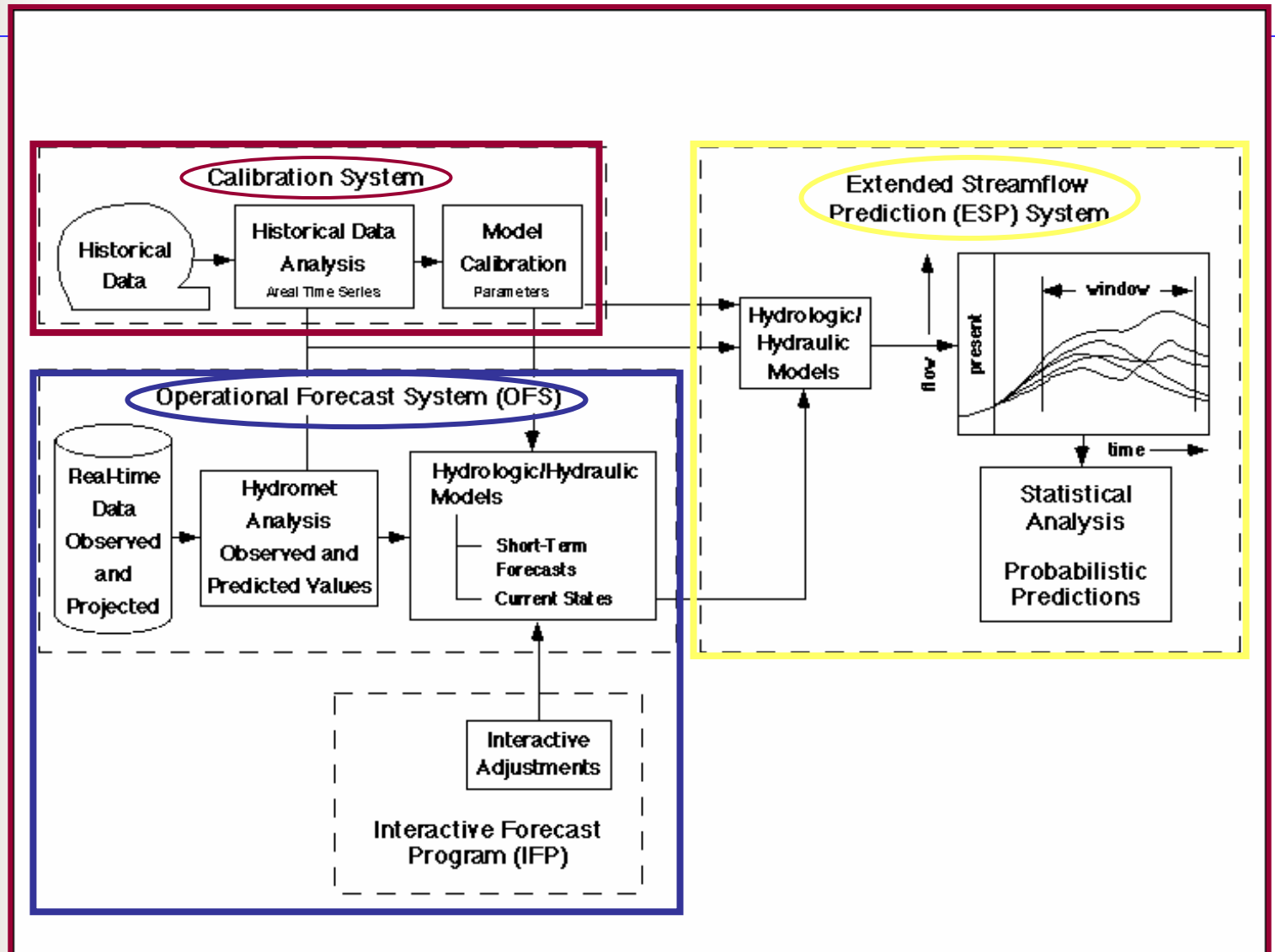

SAC-SMA Virtual Soil Probe
UZTWC + UZFWC + LZTWC +LZFSC + LZFPC
City Creek, Utah (CCSU1)
Inches
40
35
30
25
20
15
10
5
0
1
15
29
43
57
71
85
99
113
127
141
155
169
183
197
211
225
239
253
Julian Day
Average
1984
2003
2004

ESP: A conditional forecast simulation based on:

1. Current watershed conditions and model states, snow, soil moisture, flow

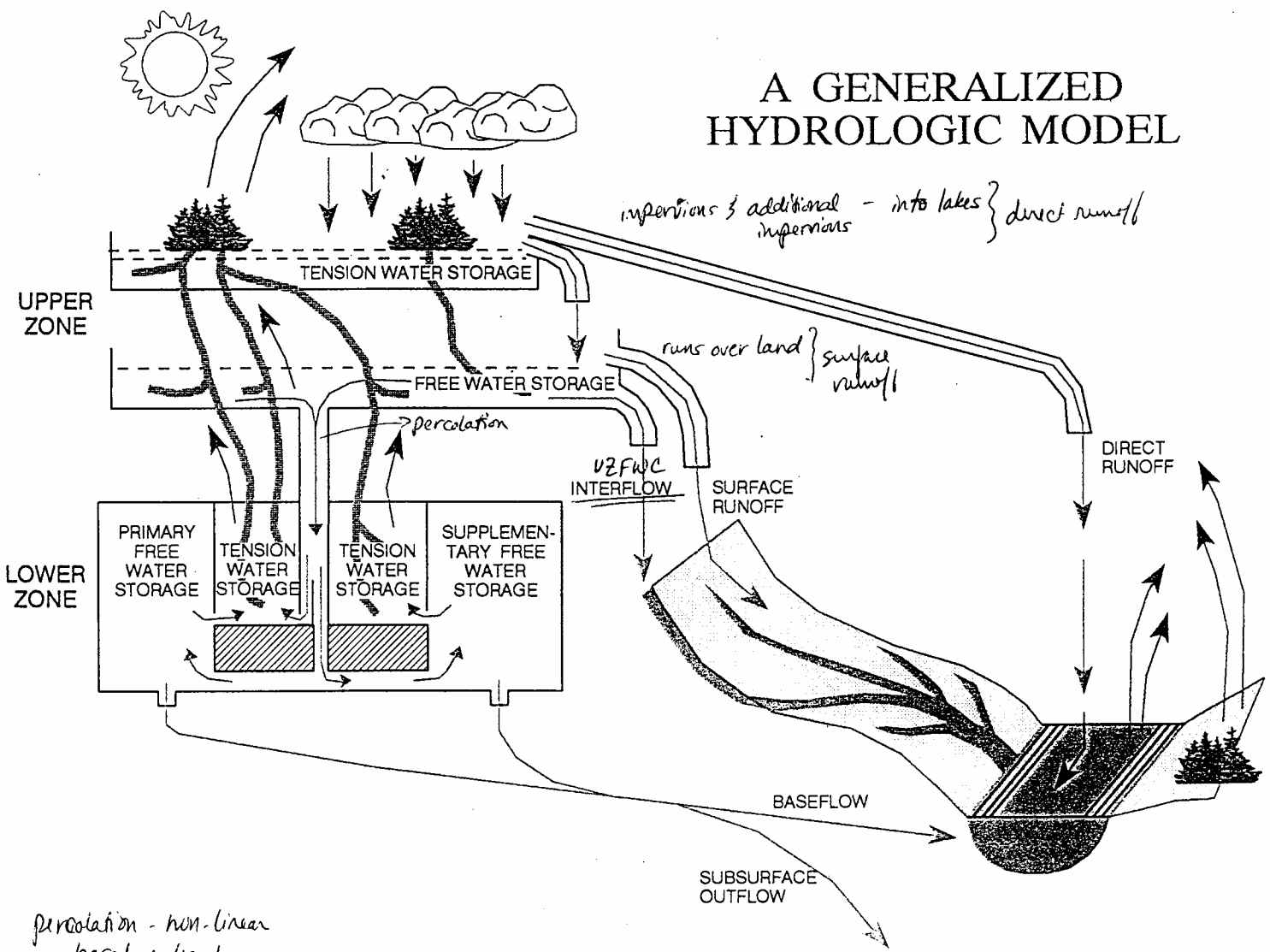
2. Known historical precipitation, Temperature and streamflow (can be weighted)

NWSRFS-Three Components



Collection of Models and Processes

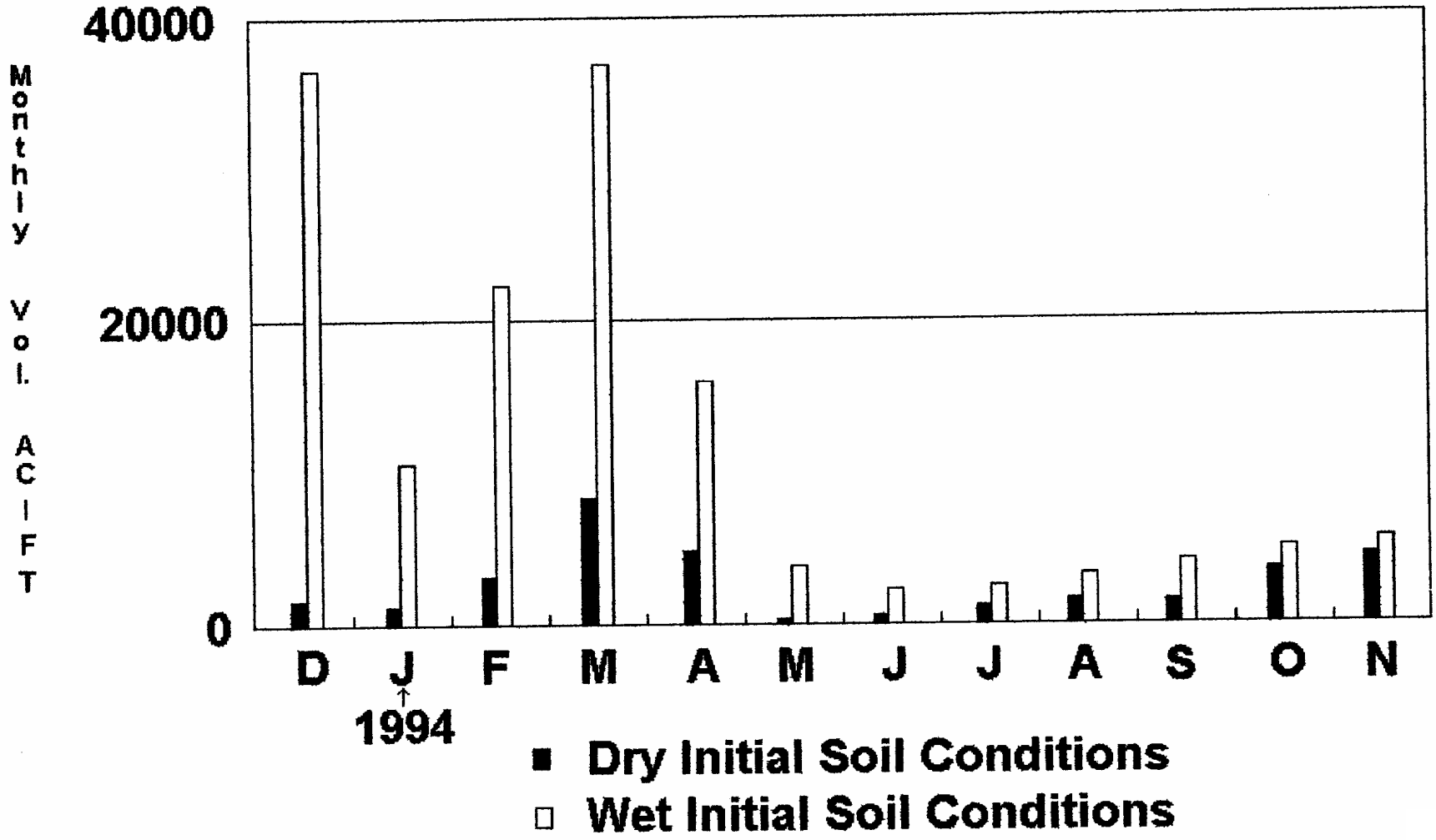
- Simulate snow accumulation and ablation
- Compute runoff
- Distribute runoff temporally from within basin to basin outlet
- Channel and/or reservoir route streamflow

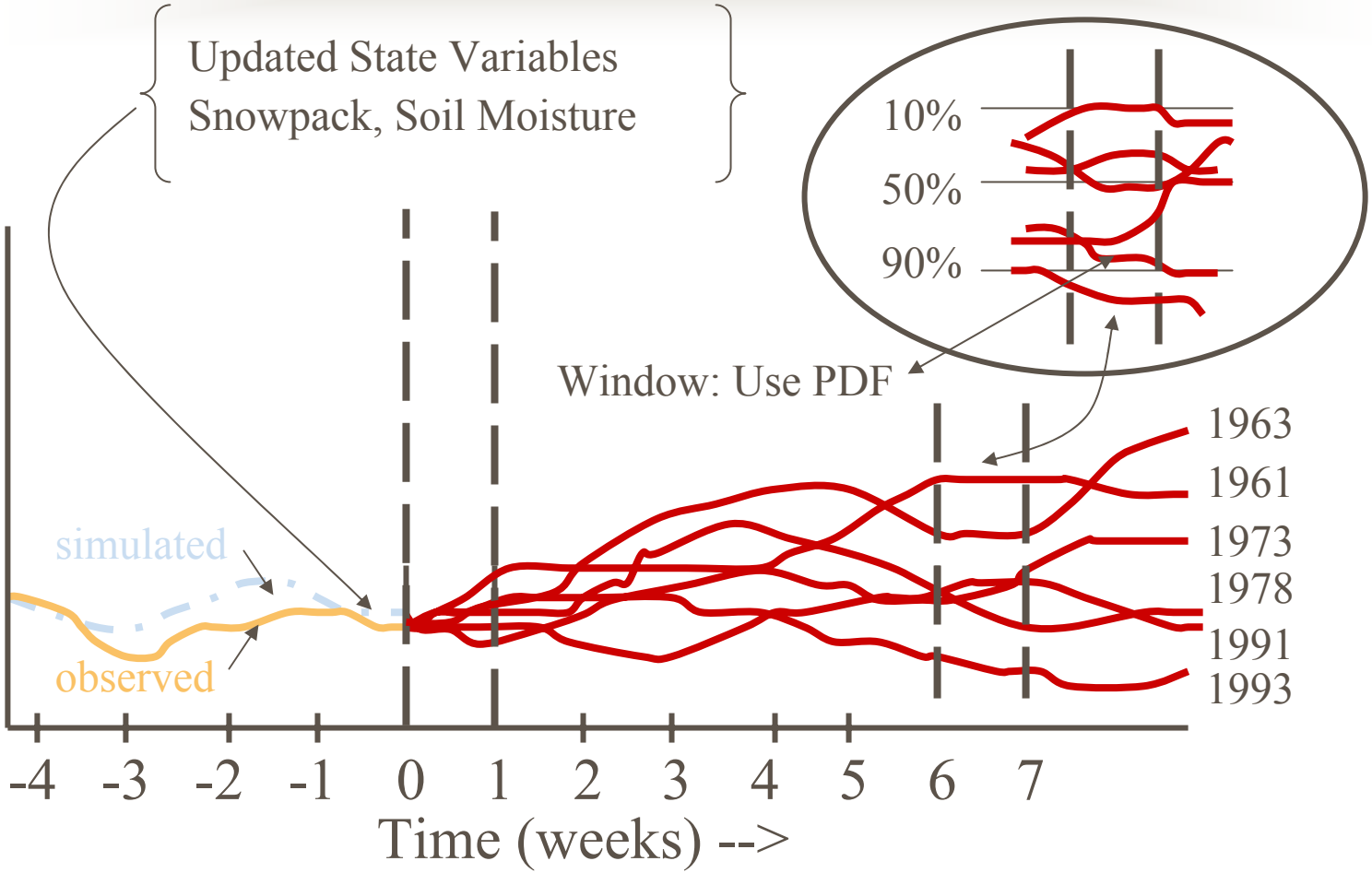

A GENERALIZED HYDROLOGIC MODEL
impervious & additional impervious - into lakes } direct runoff
UPPER ZONE
TENSION WATER STORAGE
FREE WATER STORAGE
runs over land } surface runoff
percolation
UZFWC
INTERFLOW
SURFACE RUNOFF
DIRECT RUNOFF
LOWER ZONE
PRIMARY FREE WATER STORAGE
TENSION WATER STORAGE
TENSION WATER STORAGE
SUPPLEMENTARY FREE WATER STORAGE
BASEFLOW
SUBSURFACE OUTFLOW
percolation - non-linear based on head

Ensemble Streamflow Prediction (ESP)

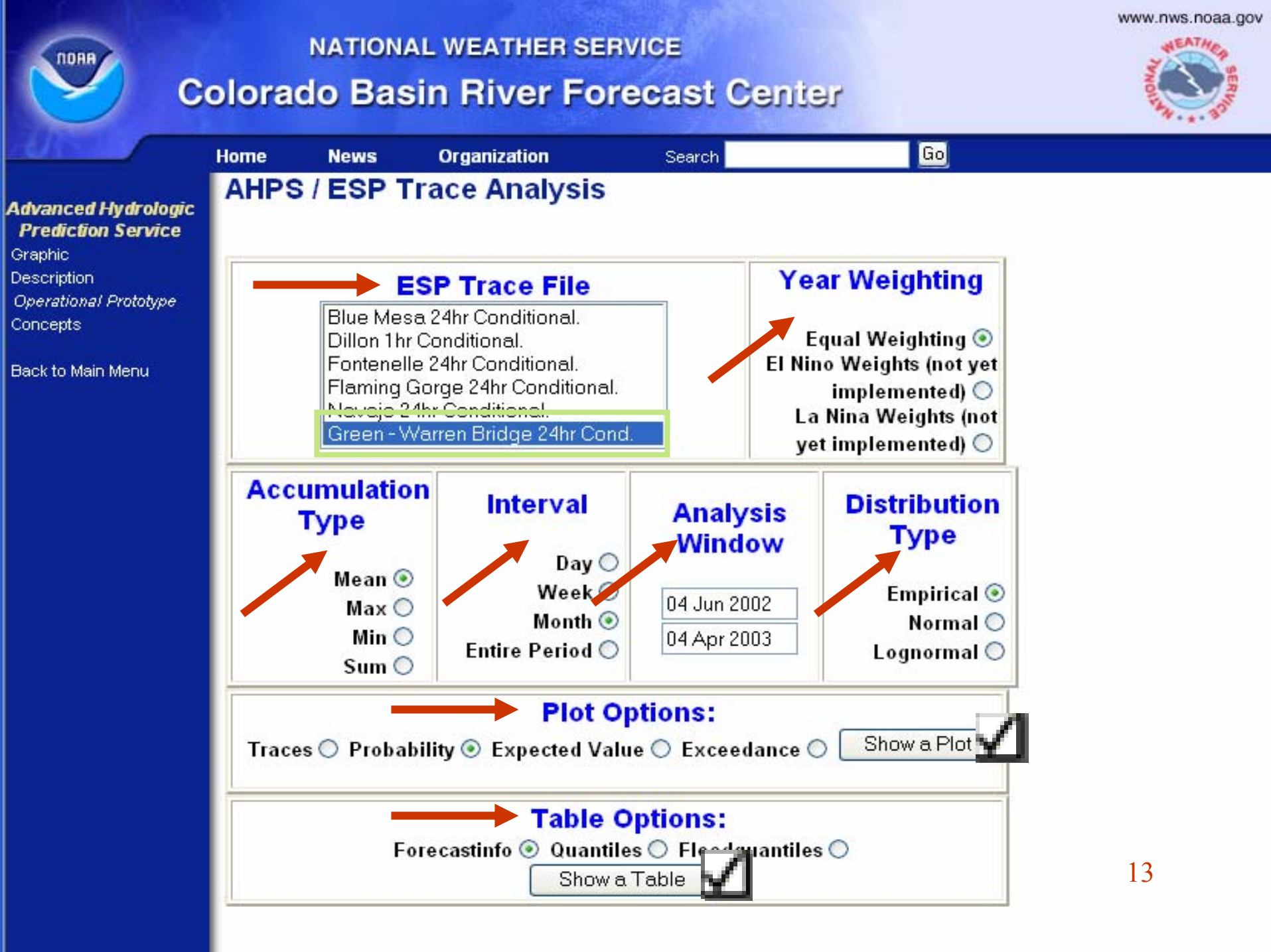
- Uses historical precipitation, temperature and evaporation data
- Uses current model states
- Produces mid- to long-range probabilistic forecast (weeks to months into the future)

ESP... Forecast
Wet vs. Dry Initial Soil Conditions
(Oak Ck - Sedonia, AZ)





Model Input	Observations TA, PP, QC	QPF QTF	Yearly Historical Time Series PP & TA based on Weighting Schemes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Dillon 1hr Conditional.
Fontenelle 24hr Conditional.
Flaming Gorge 24hr Conditional.
Green - Warren Bridge 24hr Cond.
Year Weighting
Equal Weighting
El Nino Weights (not yet implemented)
La Nina Weights (not yet implemented)
Accumulation Type
Mean
Max
Min
Sum
Interval
Day
Week
Month
Entire Period
Analysis Window
04 Jun 2002
04 Apr 2003
Distribution Type
Empirical
Normal
Lognormal
Plot Options:
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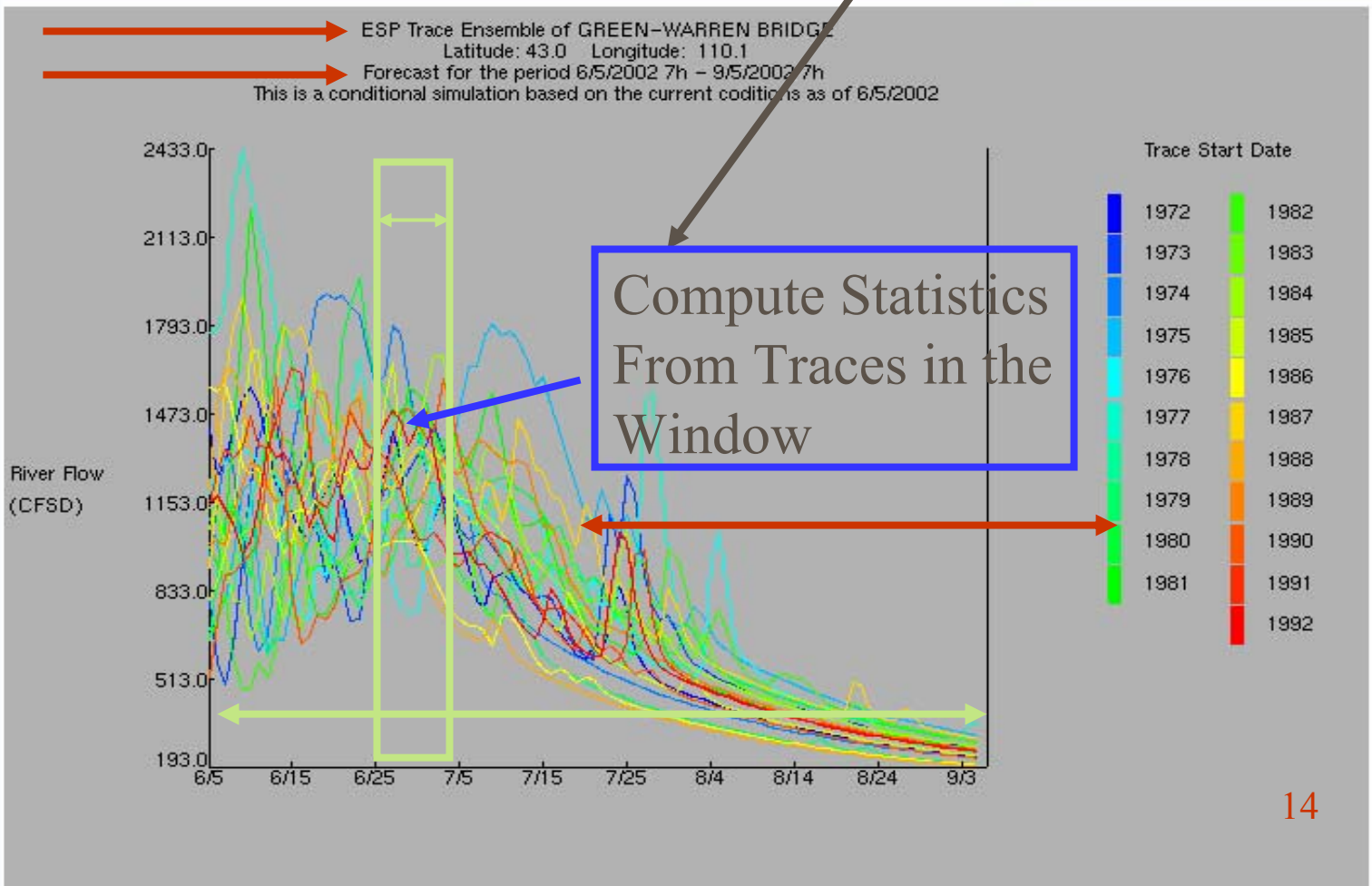


ontact Us

NVRN5 NVRN5L_F.SIM24.SQME.24.CS Navajo 24hr Conditional.

xxxxx NVRN5L_F.SIM24.SQME.24.HS Navajo 24hr Historical.

GBRW4 GBRW4R_F.SIM24.SQME.24.CS Fontenelle 24hr Conditional.

xxxxx GBRW4R_F.SIM24.SQME.24.HS Fontenelle 24hr Historical.

WBRW4 WBRW4H_F.SIM24.SQME.24.CS Green - Warren Bridge 24hr Cond.

||TE|| TraceEnsemble=WBRW4H_F.SIM24.SQME.24.CS

xxxxx WBRW4H_F.SIM24.SQME.24.HS Green - Warren Bridge 24hr Hist.

ESP Forecast Information

#

Analysis Period: 5/6/2002 24 - 12/6/2002 24 (MST)

Forecast Parameters: River Flow (Max) - (CFSD)

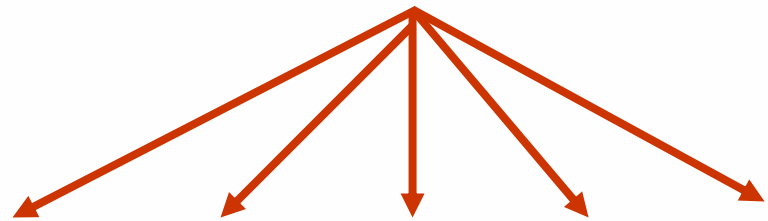
#

Forecast Interval: 1 Month

Forecast Point:

#

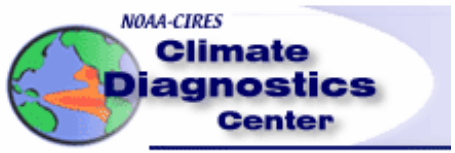
TEXT OUTPUT



#	0.90	0.75	0.50	0.25	0.10 Units
05/01/2002 - 05/31/2002	-999.00	-999.00	-999.00	-999.00	-999.00 (CFSD)
06/01/2002 - 06/30/2002	1094.29	1247.01	1380.99	1679.17	1793.95 (CFSD)
07/01/2002 - 07/31/2002	846.34	942.42	1176.40	1339.09	1754.95 (CFSD)
08/01/2002 - 08/31/2002	309.09	357.09	455.17	573.03	790.22 (CFSD)
09/01/2002 - 09/30/2002	182.06	206.78	264.84	314.11	341.17 (CFSD)
10/01/2002 - 10/31/2002	135.45	159.84	180.79	225.60	320.62 (CFSD)
11/01/2002 - 11/30/2002	108.67	125.45	140.12	158.11	175.40 (CFSD)

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

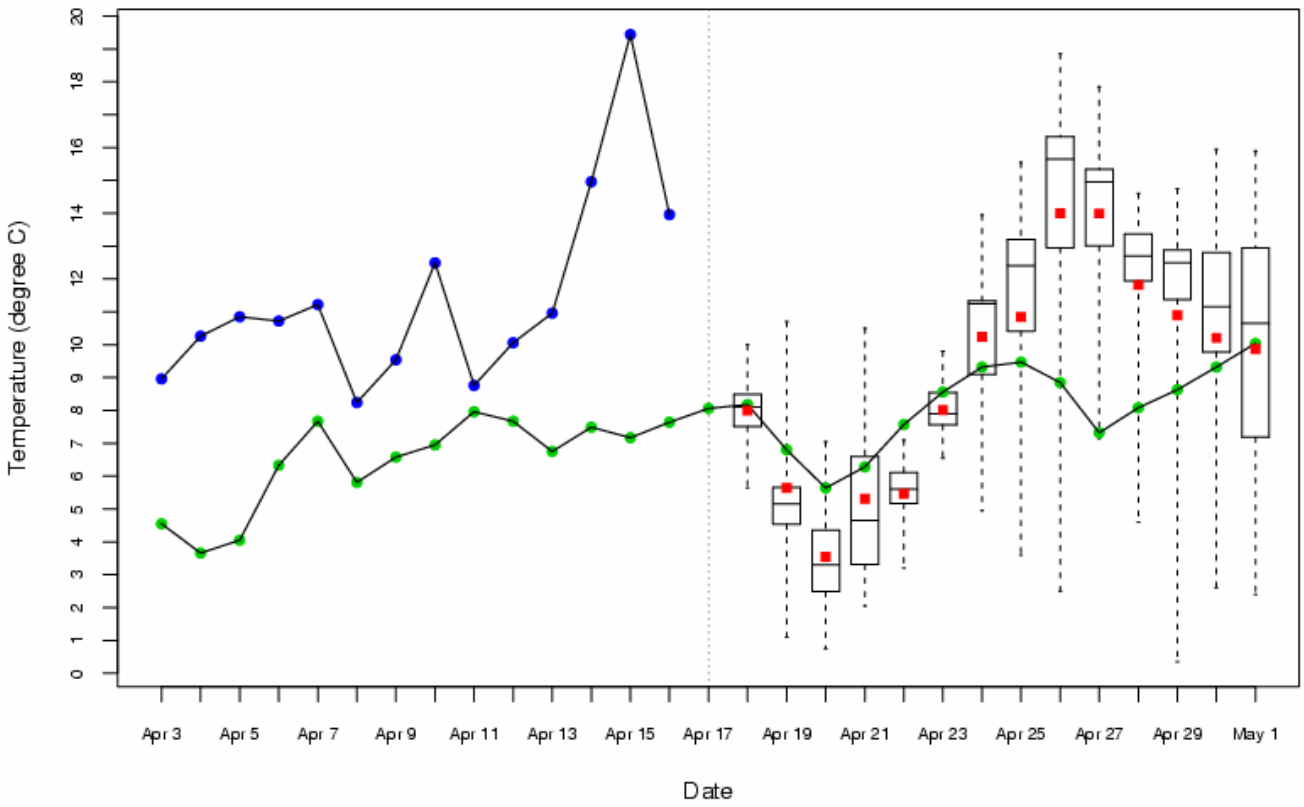
Mean Areal Temperature and Precipitation Ensembles

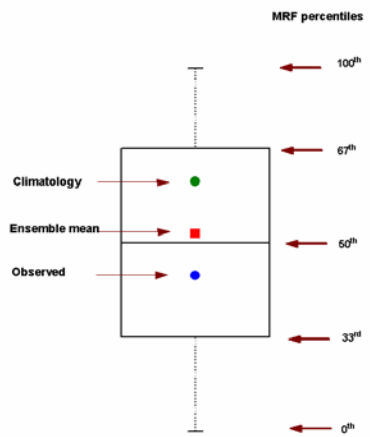
ESP Model

Probabilistic River Forecasts

Cooperative Project

CBRFC & CDC (Climate Diagnostics Center)





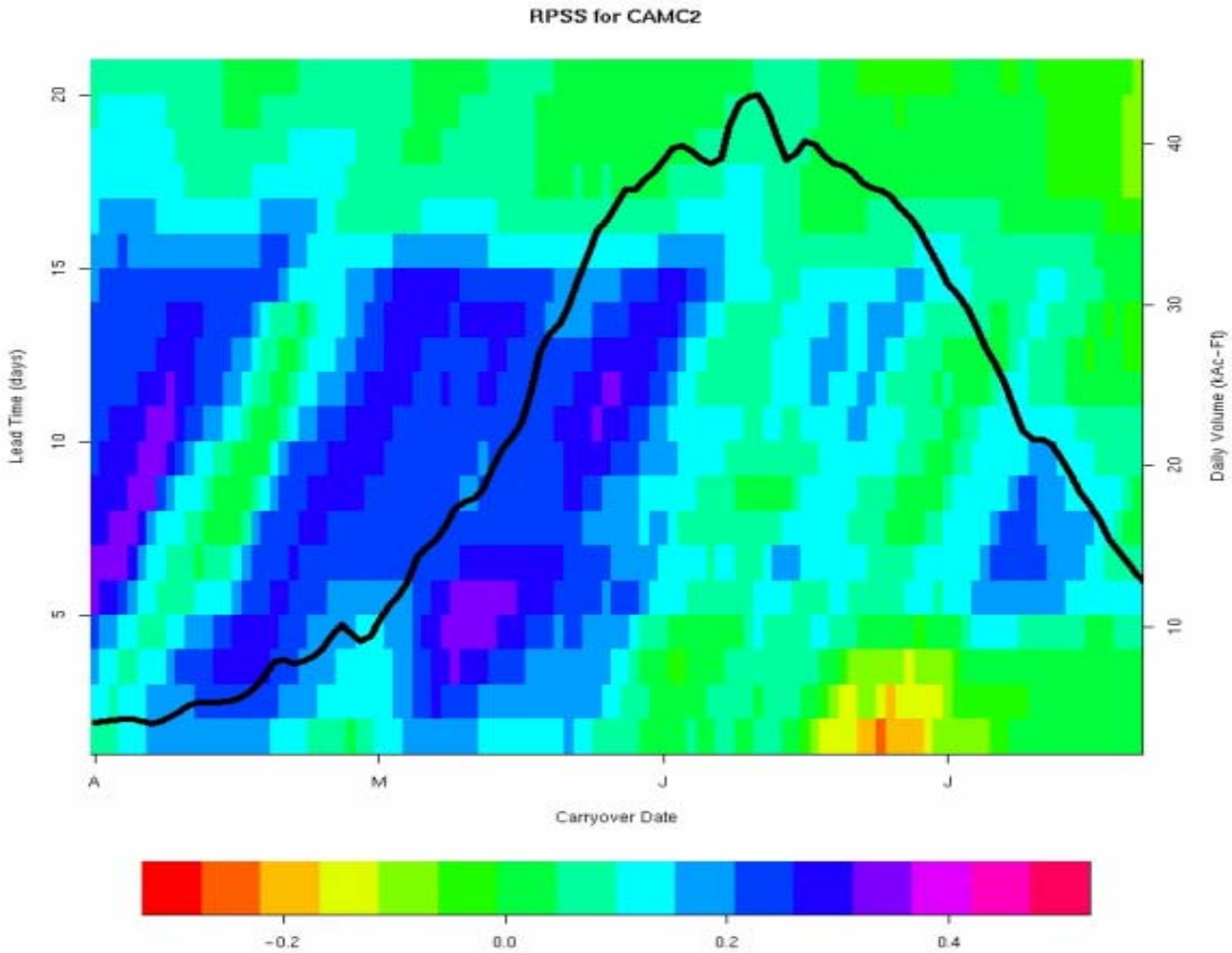
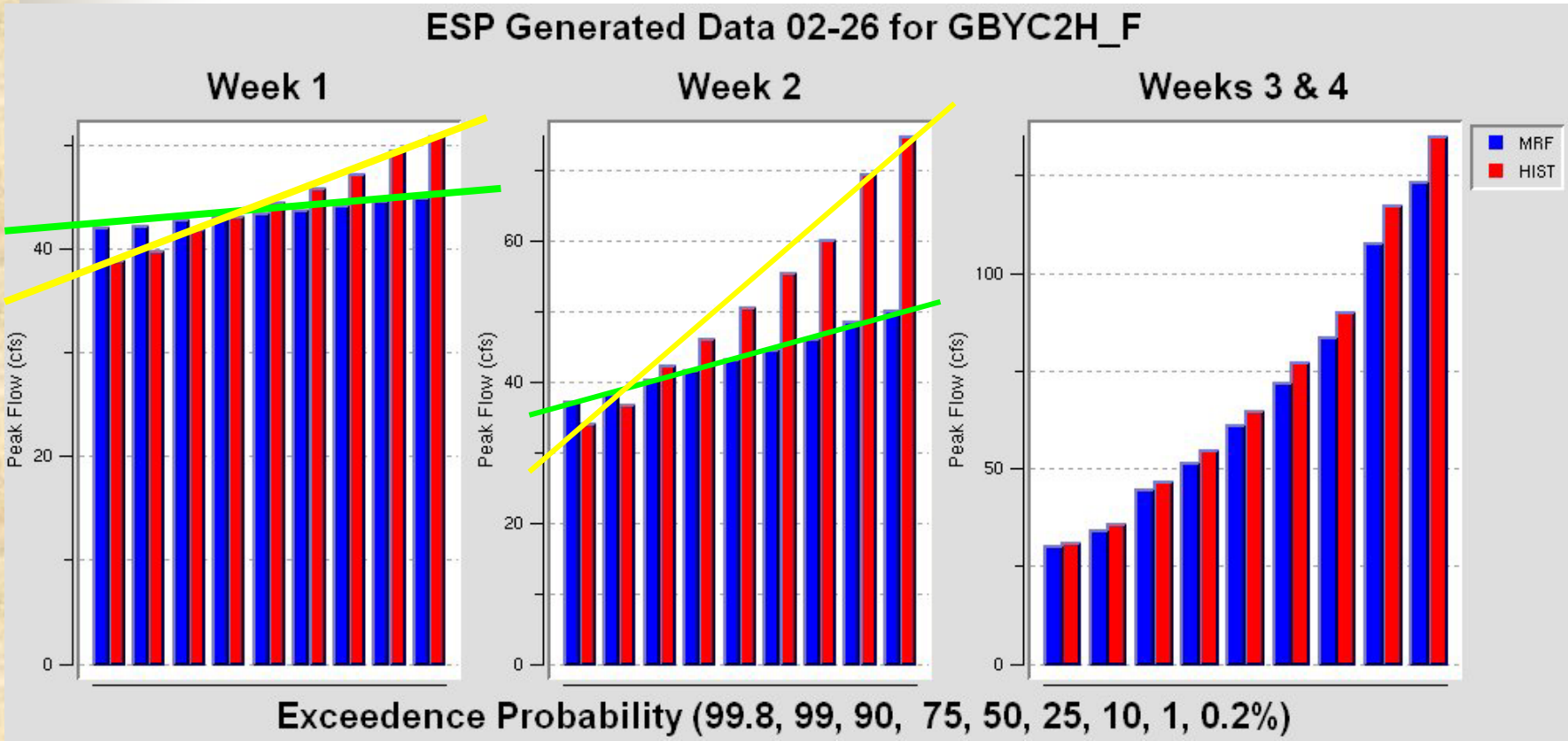


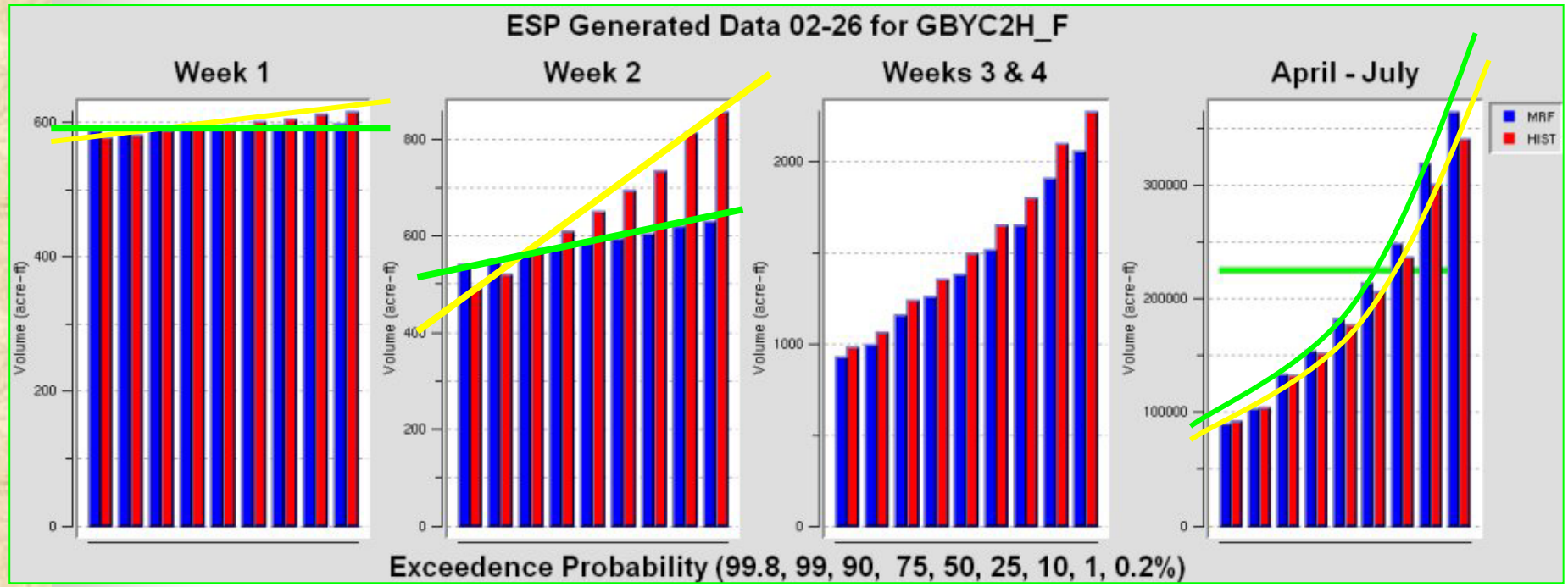
Figure 13: CAMC2 MRF forecast mean RPSS over all reforecast years. ~~Lead-time~~ Lead-time (days) on the Y-axis and forecast intialization on the X-axis. A ~~10-day~~ 10-day running mean has been applied. Superimposed black curve is the climatological simulated flow.

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.

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	