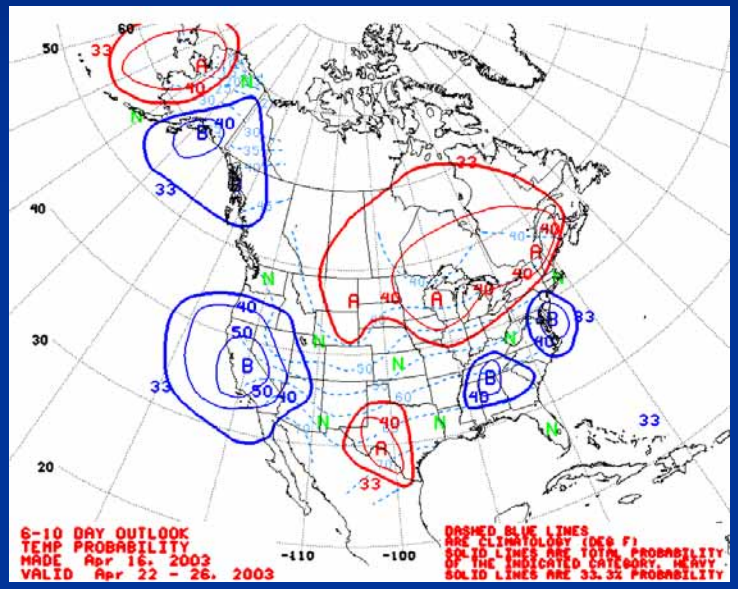
CPC Pre-adjustment Technique in Water Supply Forecasts



CPC Pre-adjustment Technique

Overview

The CPC pre-adjustment technique is a method for integrating the Climate Prediction Center (CPC) forecasts into Ensemble Streamflow Prediction (ESP) forecasts.

After some definition of terms, the following pages will describe:

I. CPC Forecasts Used

II. ESP Trace Ensembles

III. Climate Adjusted Ensembles

CPC Pre-adjustment Technique

Definitions

Ensemble Hydrologic Forecasting Definition:

"A process whereby a continuous hydrologic model is successively executed several times for the same forecast period by use of varied data input scenarios… A common method employed to obtain a varied data input scenario is to use the historical meteorological record …"

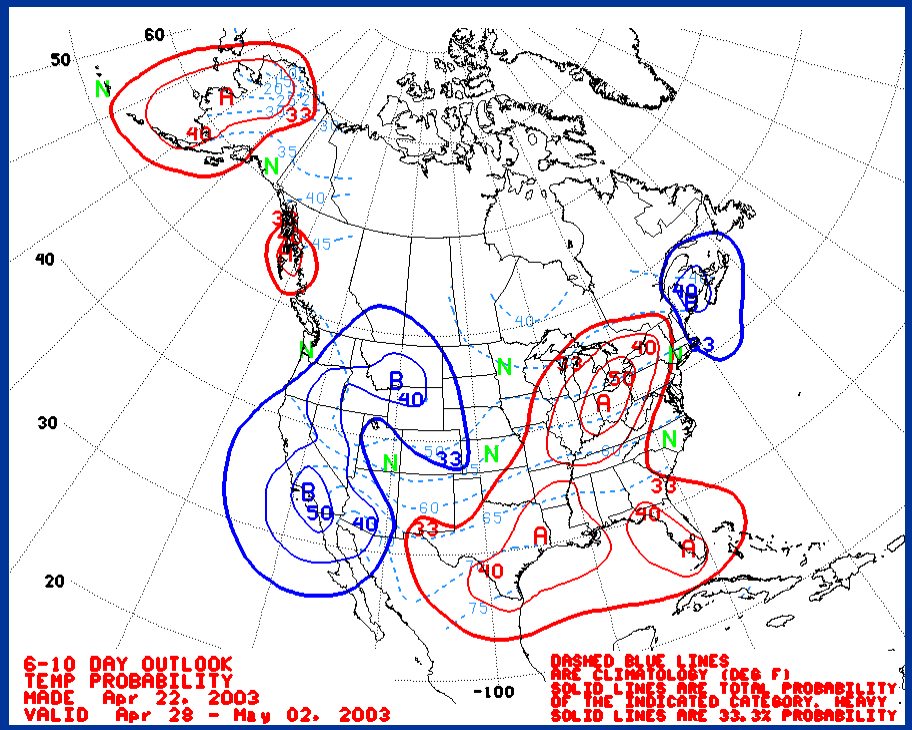
CPC Pre-adjustment Technique

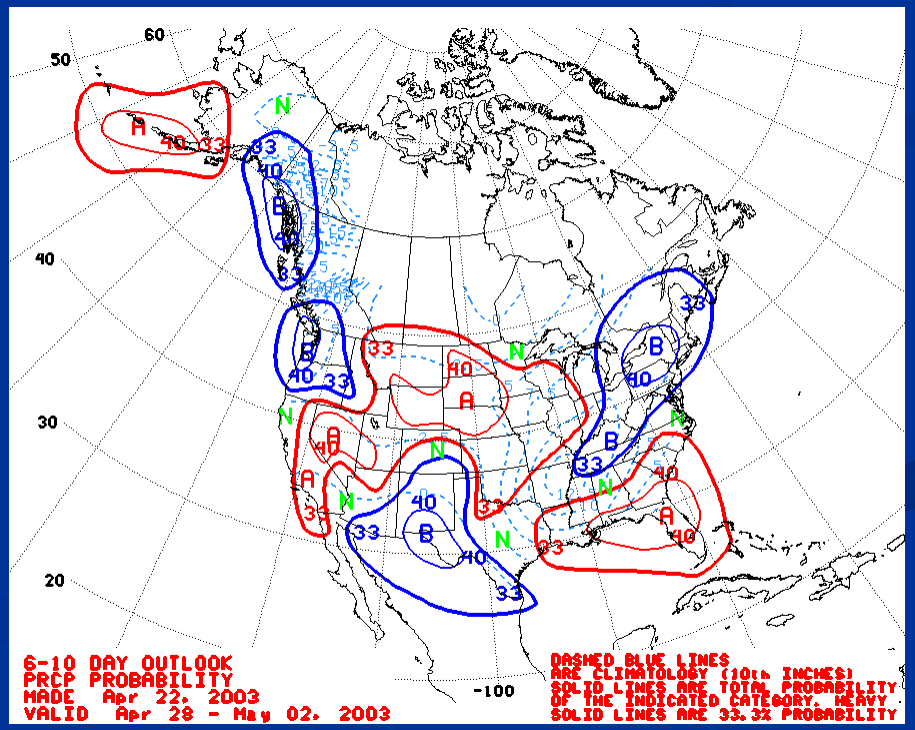
Definitions

- **PDF :** Probability Density Function
- **Trace :** A hydrograph of an extended-range time horizon showing one of many scenarios generated through an ensemble forecast process.
- **Error Model :** A statistical process which accounts for the uncertainty in the initial conditions and hydrologic model.
- **Conditional Simulation :** A set of traces generated from historical time-series being applied to the current model initial conditions

CPC Forecasts

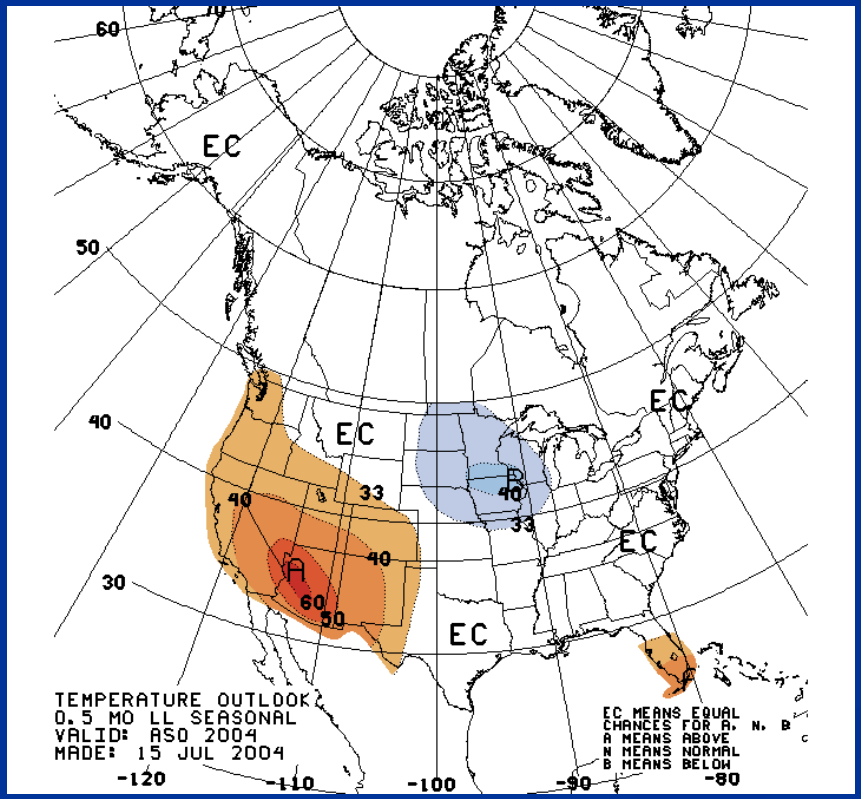
CPC Short Term Forecasts (6-10 days) are produced daily for temperature and precipitation. Currently RFCs must enter these forecasts manually by forecast regions.

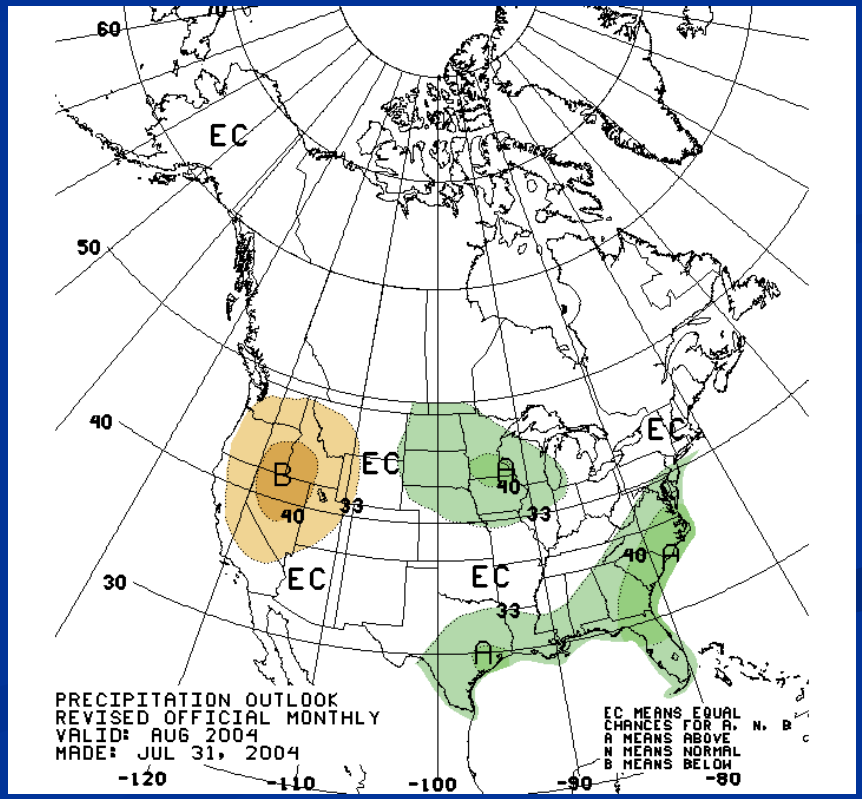




CPC Forecasts

CPC Long Lead Forecasts (monthly and seasonal) are produced each month for temperature and precipitation. RFCs reference gridded products produced by the CPC.





CPC Forecasts

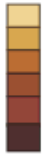
CPC forecasts are given as probability of occurrence using a tercile system of above normal, near normal and below normal.

The CPC pre-adjustment technique converts these probabilities into real physical temperature and precipitation adjustments.

Climate Outlook

The key below is used to interpret each of the color versions of the ***Climate Outlook*** products. In areas where confidence in predictive skill has been established, the probabilities of the above normal, near normal or below normal categories are increased accordingly above the Climatology level of 1/3 (33.3%) for each category. These probabilities are contoured using colors as depicted in the key below.

In those areas where the skill of our present prediction tools is not sufficient, the default is equal chances (white color). The probabilities of experiencing each of the three categories (above normal, near normal or below normal) remain equally likely (1/3) in the white areas on attached maps.

Precip	Temp	Probability of Occurence			Most likely category
		Above	Near	Below	
		80.0%-90.0%	16.7%-06.7%	03.3%	"Above"
		70.0%-80.0%	26.7%-16.7%	03.3%	"Above"
		60.0%-70.0%	33.3%-26.7%	06.7%-03.3%	"Above"
		50.0%-60.0%	33.3%	16.7%-06.7%	"Above"
		40.0%-50.0%	33.3%	26.7%-16.7%	"Above"
		33.3%-40.0%	33.3%	33.3%-26.7%	"Above"
		33.3%-30.0%	33.3%-40.0%	33.3%-30.0%	"Near Normal"
		30.0%-25.0%	40.0%-50.0%	30.0%-25.0%	"Near Normal"
		33.3%-26.7%	33.3%	33.3%-40.0%	"Below"
		26.7%-16.7%	33.3%	40.0%-50.0%	"Below"
		16.7%-06.7%	33.3%	50.0%-60.0%	"Below"
		06.7%-03.3%	33.3%-26.7%	60.0%-70.0%	"Below"
		03.3%	26.7%-16.7%	70.0%-80.0%	"Below"
		03.3%	16.7%-06.7%	80.0%-90.0%	"Below"
		33.3%	33.3%	33.3%	"Equal Chances"

ESP Trace Ensembles

The following is a flow diagram for how RFCs generate trace ensembles of streamflow. The traces are conditional simulations since they use current soil moisture and snow conditions as a starting point.

The role of the CPC pre-adjustment technique is to adjust the probability density function of the historical mean areal precipitation (MAP) timeseries and the historical mean areal temperature (MAT) timeseries. The adjusted MAPs and MATs are used to predict basin runoff.

ESP Trace Ensembles

CPC Climate Forecast

Daily RFC Forecasting
- Data Ingest
- Data QC
- Model Updating

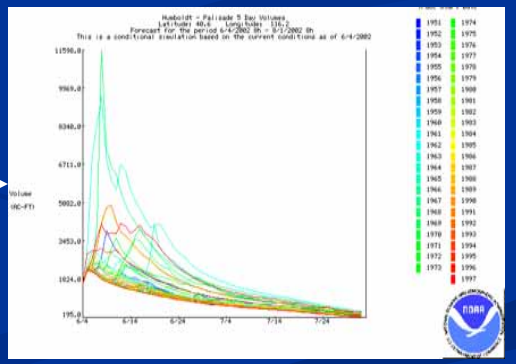
Current Conditions
- Soil
- Snow
- Reservoir Levels
- Streamflow

Historical Time-Series

Forecast MAP & MAT

Input MAP & MAT

NWSRFS Models



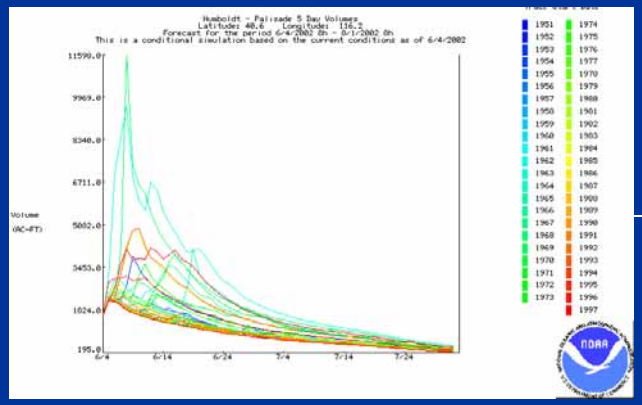
ESP Trace Ensembles

Products

Once the ensemble traces have been generated, the traces are analyzed and statistics are derived. The RFC is capable of producing numerous products based on the ESP trace ensembles. The types of statistical products and graphical displays available include:

- Trace ensembles
- Probability Histograms
- Exceedance Probability Plots

Analysis of ESP Trace Ensembles



Error Model

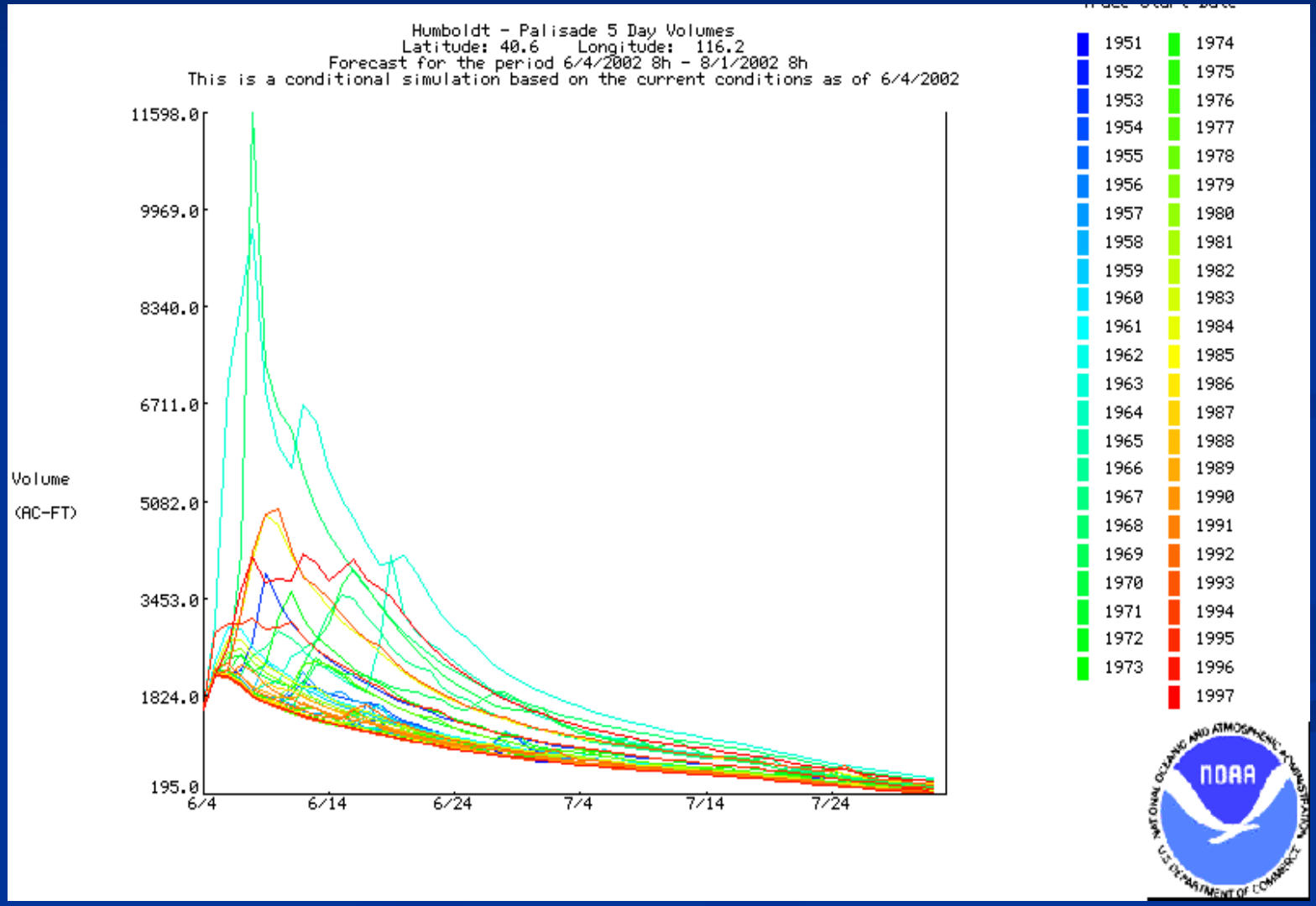
Statistical Analysis

Forecasts & Products

- Water Supply
- Peak Flow
- Minimum Flow
- User Defined Products

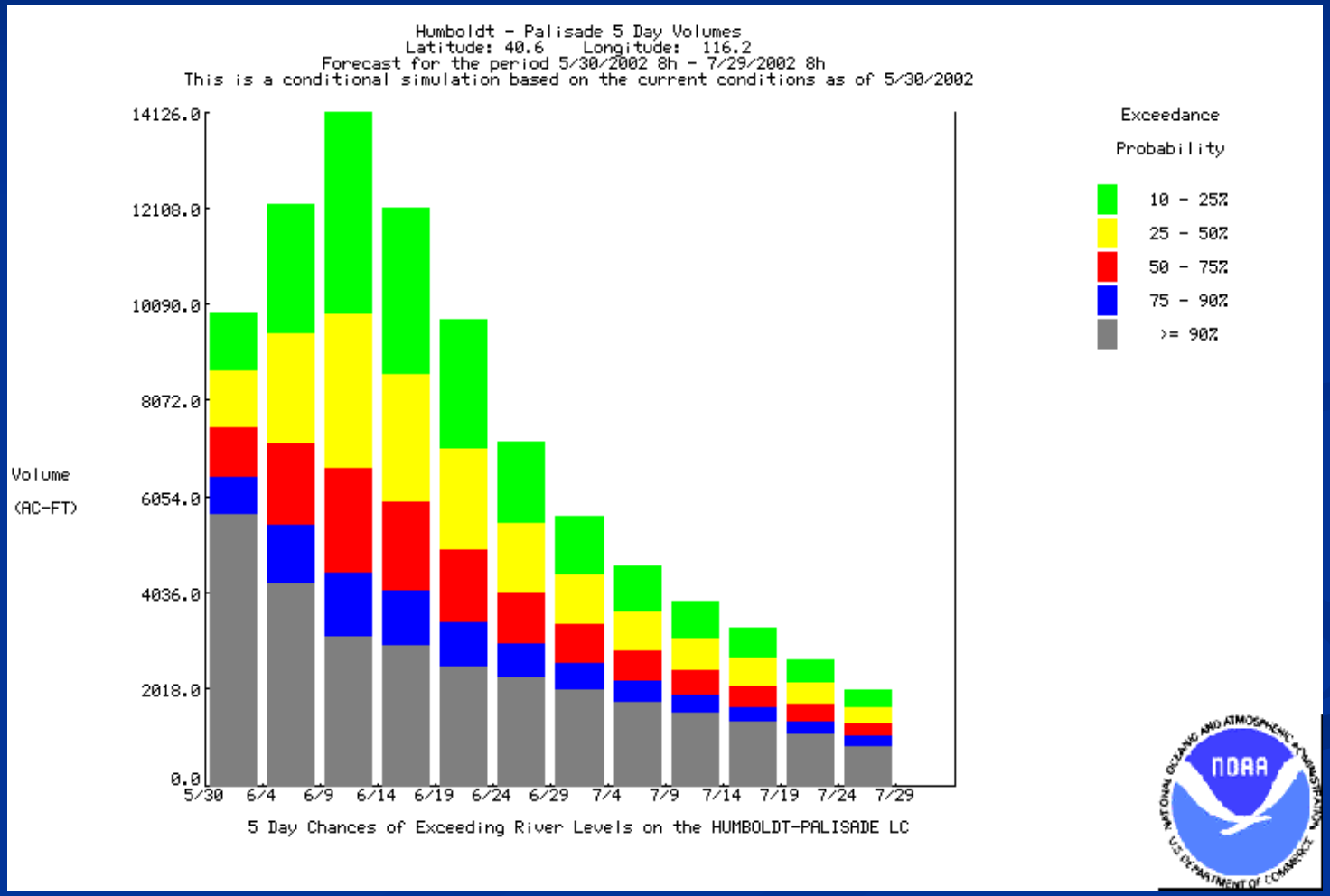
ESP Products

Trace Ensembles



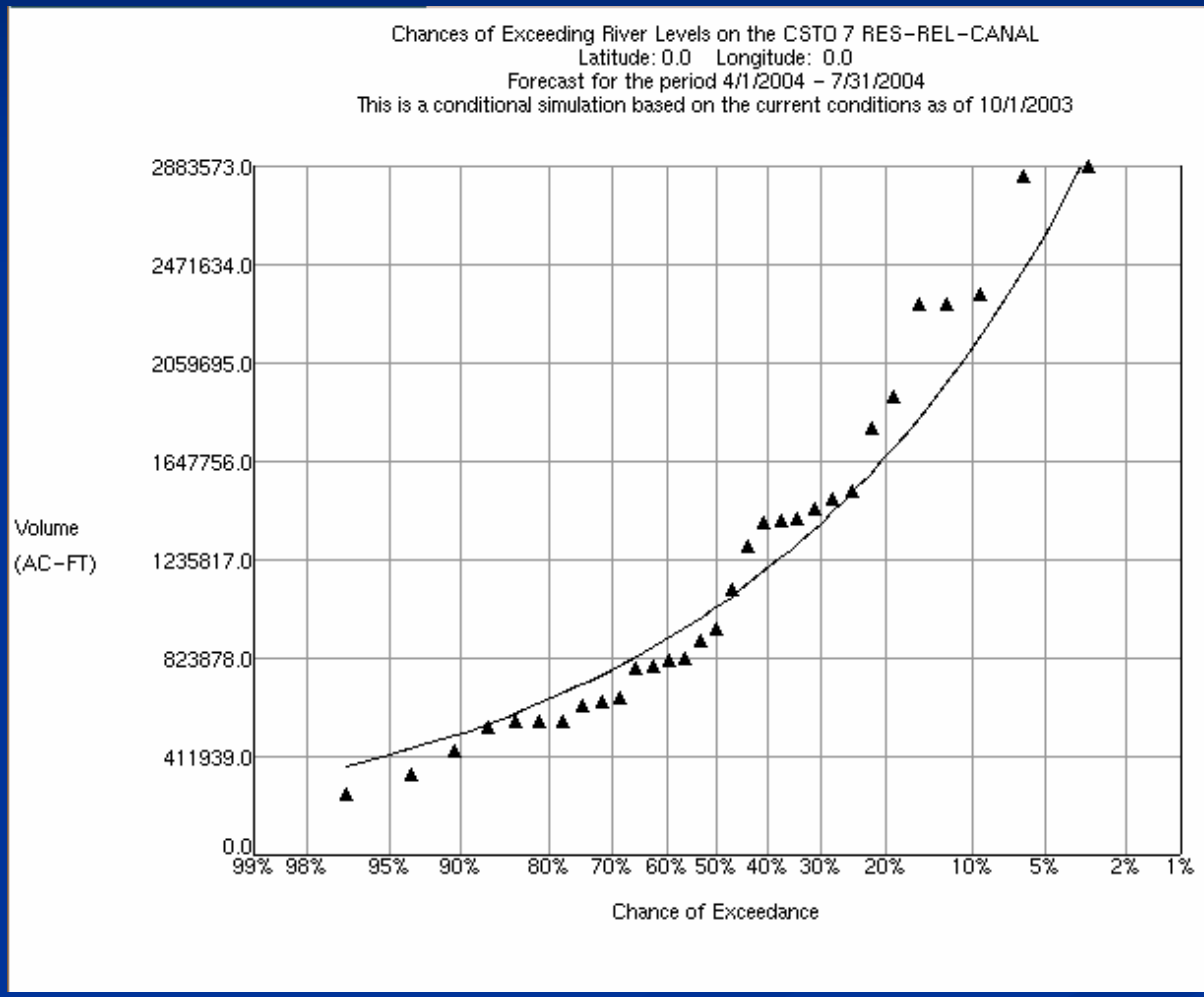
ESP Products

Probability Histograms



ESP Products

Exceedance Probability Plots

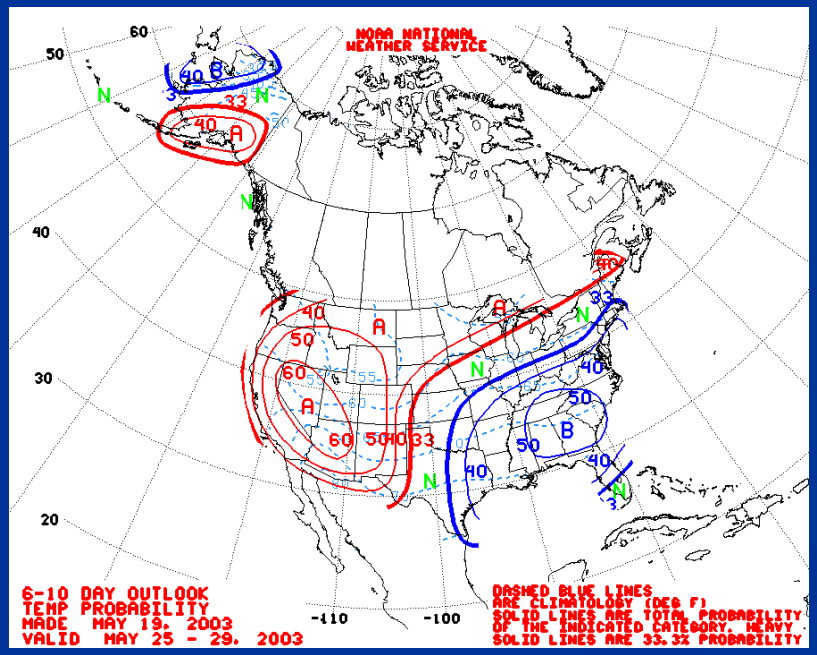


Friant Dam

April-July Runoff Volumes

Climate Adjustments

ESP trace ensembles represent a climatological forecast of future streamflow. In order to incorporate the climate trends and forecasts produced by the CPC, their forecasts must be read and converted into physical shifts in temperature and precipitation.



± how many °F for May 25 – 29 ??

Climate Adjustments

- Temperature adjustments

  For the historical temperature timeseries an additive adjustment is computed based on the mean and standard deviation of temperature (basin MAT) for each day of a calendar year (5-day running average).

- Precipitation adjustments

  For the historical precipitation timeseries a multiplicative adjustment is computed based on the mean and standard deviation of precipitation (basin MAP) for each day.

Climate Adjustment Example

TYPE=MAT UNIT=DEGF

Temperature statistics (day, mean, std, min, max)

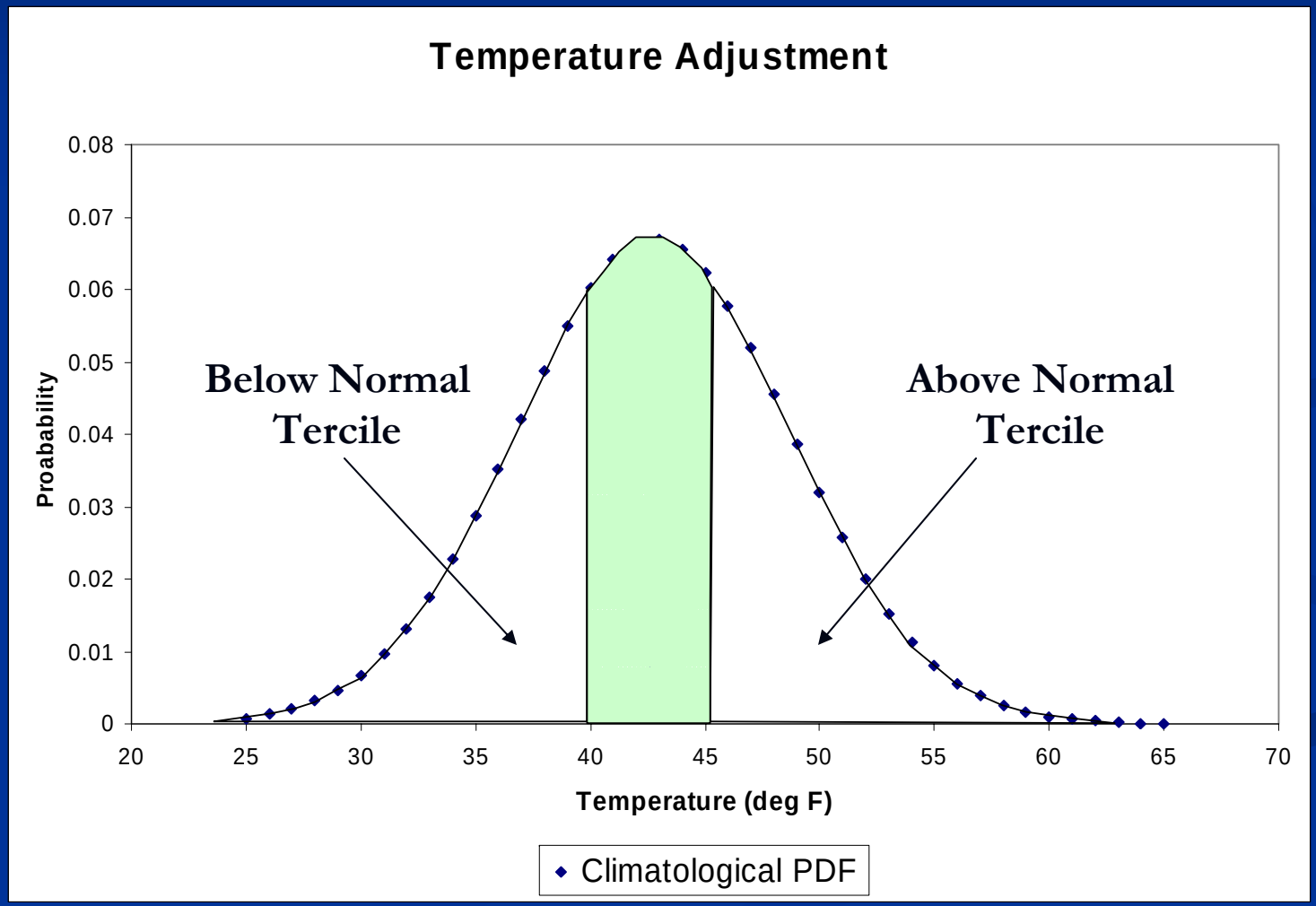
5-day averages starting on January 1

1	25.506	5.563	13.083	34.655
2	25.485	5.926	13.948	34.424
3	25.567	6.261	14.410	37.005
.				
.				
148	42.754	5.952	29.680	55.777

Example of an MAT mean and standard deviation for Day 148 (5-day average for May 25 - 29)

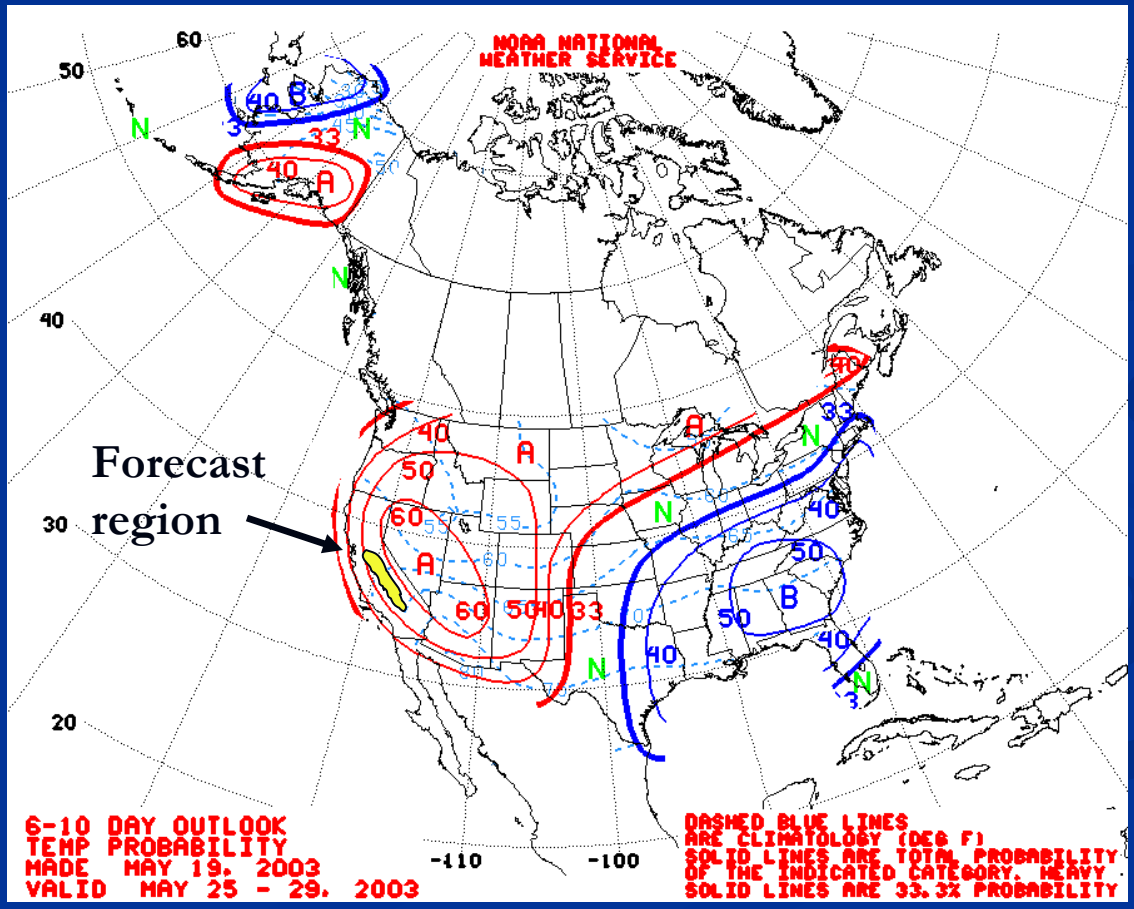
Climate Adjustment Example

Example of a climatological PDF for May 25 - 29
Mean Temp = 42.754 °F; std = 5.952 °F



Climate Adjustment Example

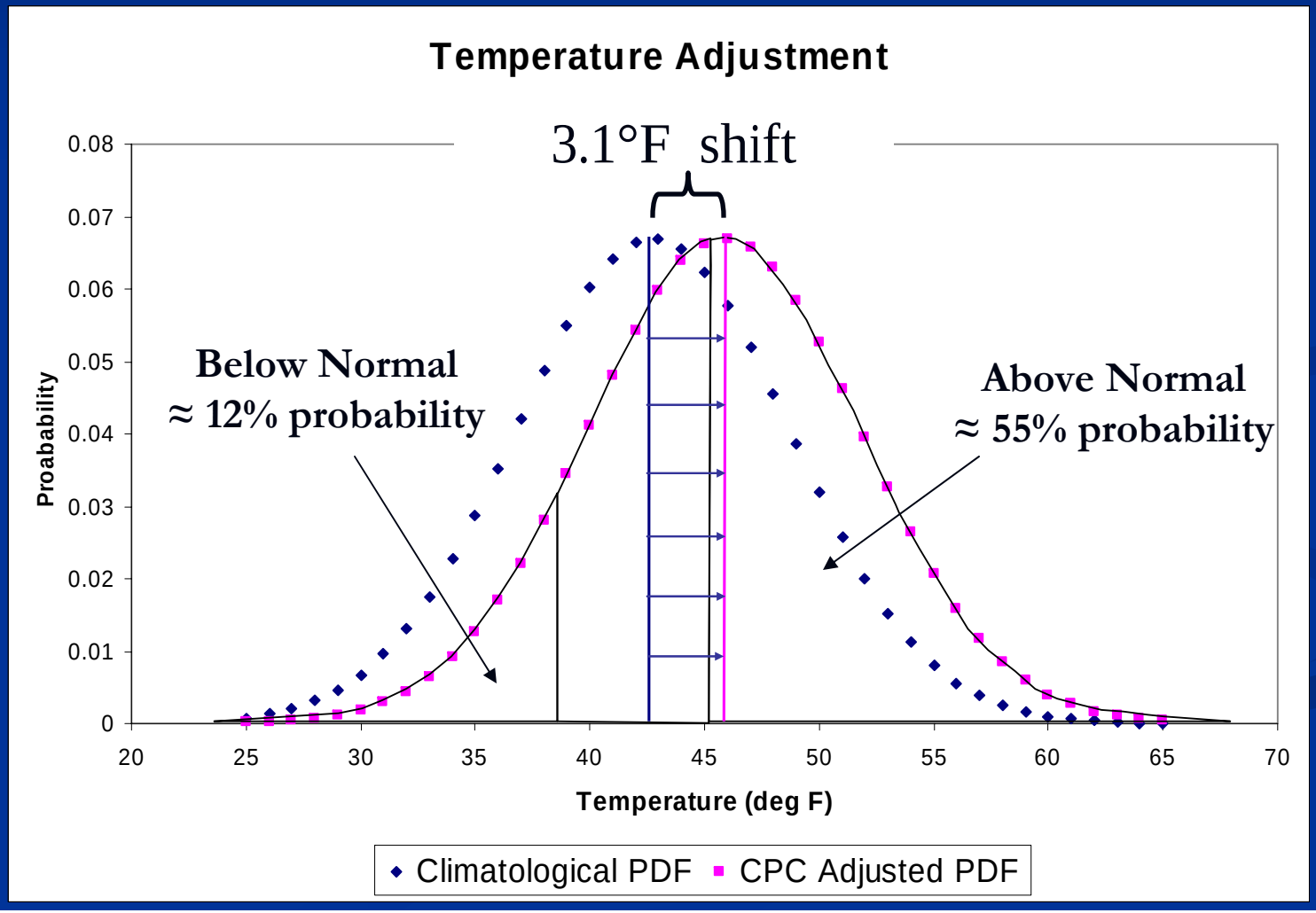
The CPC forecast for May 25 – 29 indicated a probability of about 55% for Above Normal temperatures for the highlighted forecast region.



Climate Adjustment Example

CPC Adjusted PDF for May 25 - 29

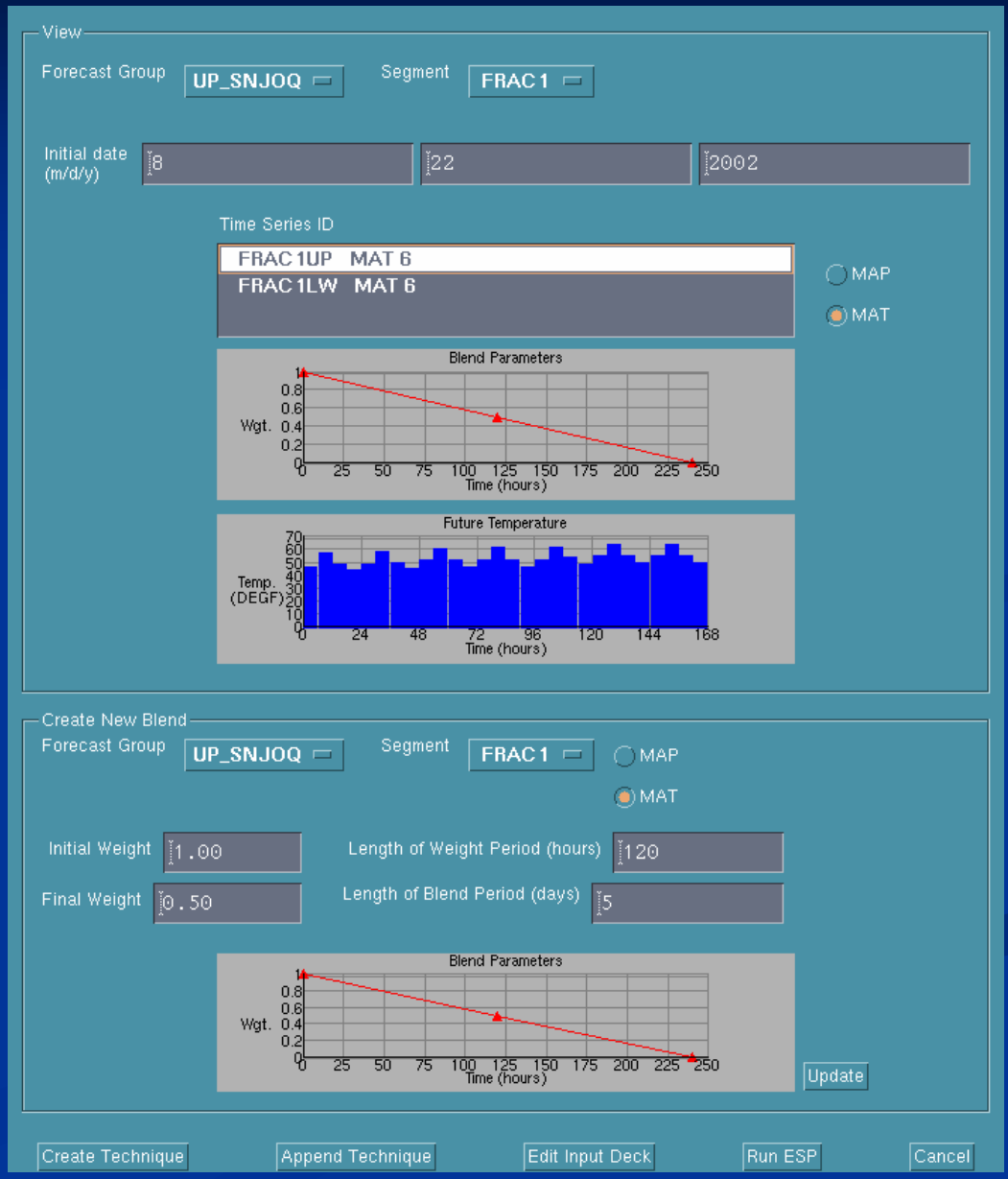
New mean = 45.9 °F



Climate Adjustments

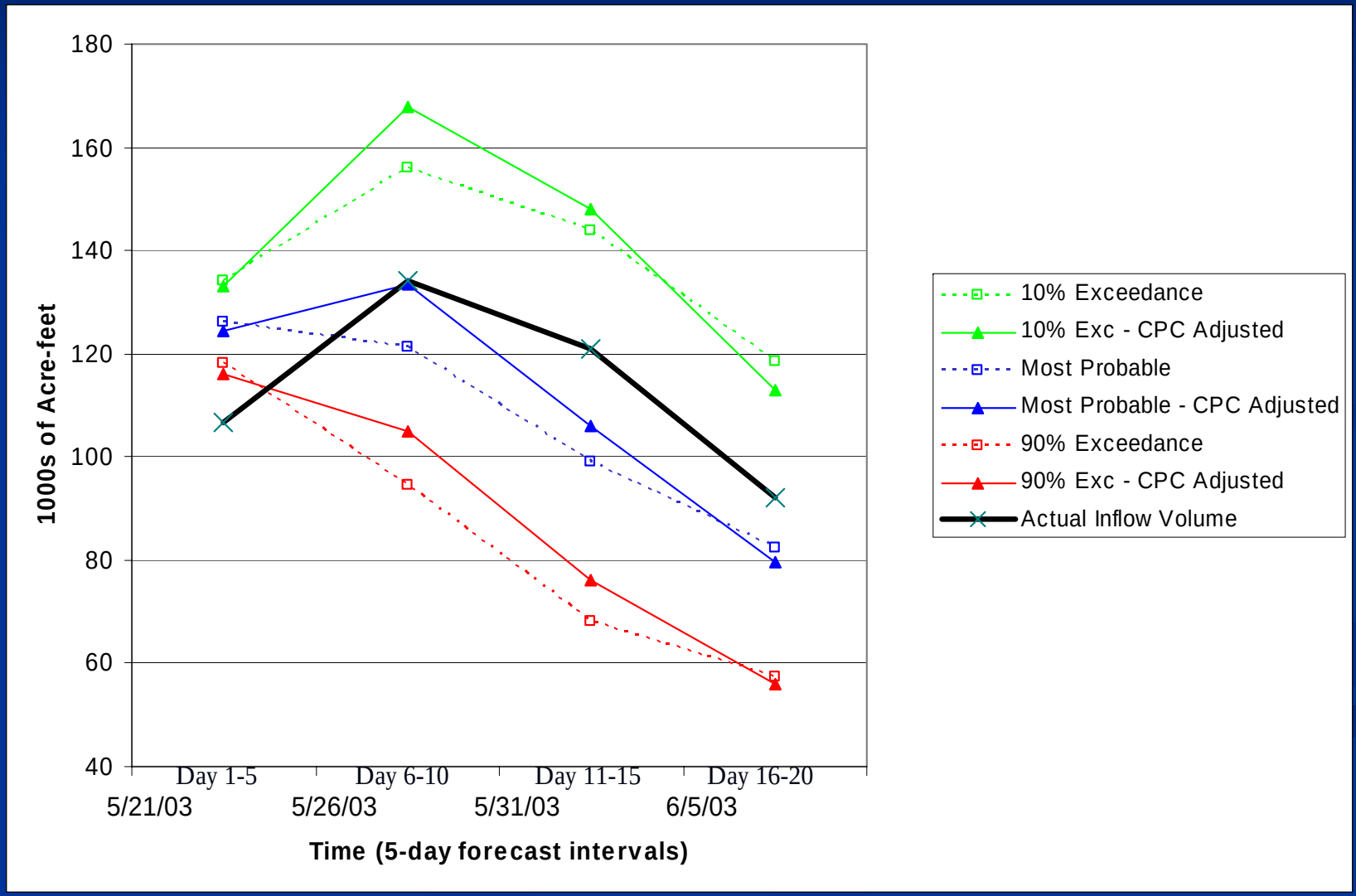
RFCs routinely include forecasts for the first 5 - 10 days for MAP and MAT (the length of the forecasts vary among RFCs).

The deterministic forecasts are blended into the CPC adjusted timeseries with user defined weights.



CPC Pre-adjustment Technique

Example of CPC-adjusted Forecasted Inflows for 20 days



CPC Pre-adjustment Technique

Summary

- CPC produces forecasts of anomalous precipitation and temperature for both short lead times (6-10 days) and long lead times (1 month to 1 year).
- Unadjusted ESP forecasts represent a climatological forecast of streamflow based on initial conditions.
- CPC Climate forecasts are used to adjust historical MAPs/MATs to reflect the most current climate outlook.
- Water Supply forecasts are derived from an ensemble of streamflow traces produced from CPC adjusted MAPs/MATs.

CPC Pre-adjustment Technique

References

For additional detail see:

http://hydrology.nws.noaa.gov/oh/hrl/papers/ams/ams98-6.htm

http://www.nws.noaa.gov/oh/hrl/nwsrfs/esp/indexesp.htm