Colorado River Basin
Water Year 2005 Outlook Briefing
November 9, 2004

"Colorado River Basin Streamflow Outlook"

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Presentation Outline

Outlooks/Forecasts
- **Time Table**

‘Defining the Drivers’
- **Main influences on Outlooks/Forecasts**

‘Using the Drivers’
- **Model – NWSRFS ESP**

‘Applying the Drivers’
- **Using ESP – 2005 Outlook for Lake Powell**

Time Line For Early Season Outlooks

Outlooks Begin Oct/Nov If Requested

Forecasts Begin Jan 1

Forecast Target (April – Jul Volume)

Month

O N D J F M A M J J

Outlook Drivers

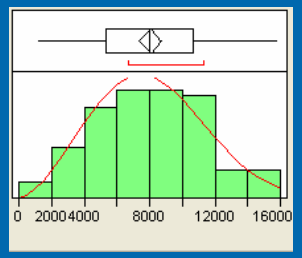
- Historical Observations
- Fall Flow
- Soil Moisture State
- Climate Forecast/Indices

Forecast Drivers

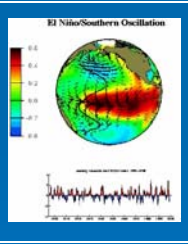
- Historical Observations
- Snow Water Equivalent
- Precipitation
- Soil Moisture State
- Current Monthly Flow
- Climate/Weather Forecasts

Drivers For Early Season Outlooks Made In Oct/Nov For Spring Runoff Volume Into Lake Powell

(1) Historical Observations/Climatology
Forecasting For Dummies
Best Guess If you Knew Nothing Else
Trivial Forecast 'To Beat'



(2) Initial Watershed Conditions
Antecedent Flow - Persistence
Soil Moisture State
Carryover Effect in Protracted Wet/Dry Period
Snow Pack
Reservoir Status (If Regulated Flow)



(3) Future Weather/Climate Variability
Could Help in High ENSO States
Climate Indices/Climate Forecast Models

(4) Model Bias Correction

Objectively Accounting for the Drivers

ENSEMBLE STREAMFLOW PREDICTION

ESP

Developed and Used in NWS Since 1970s

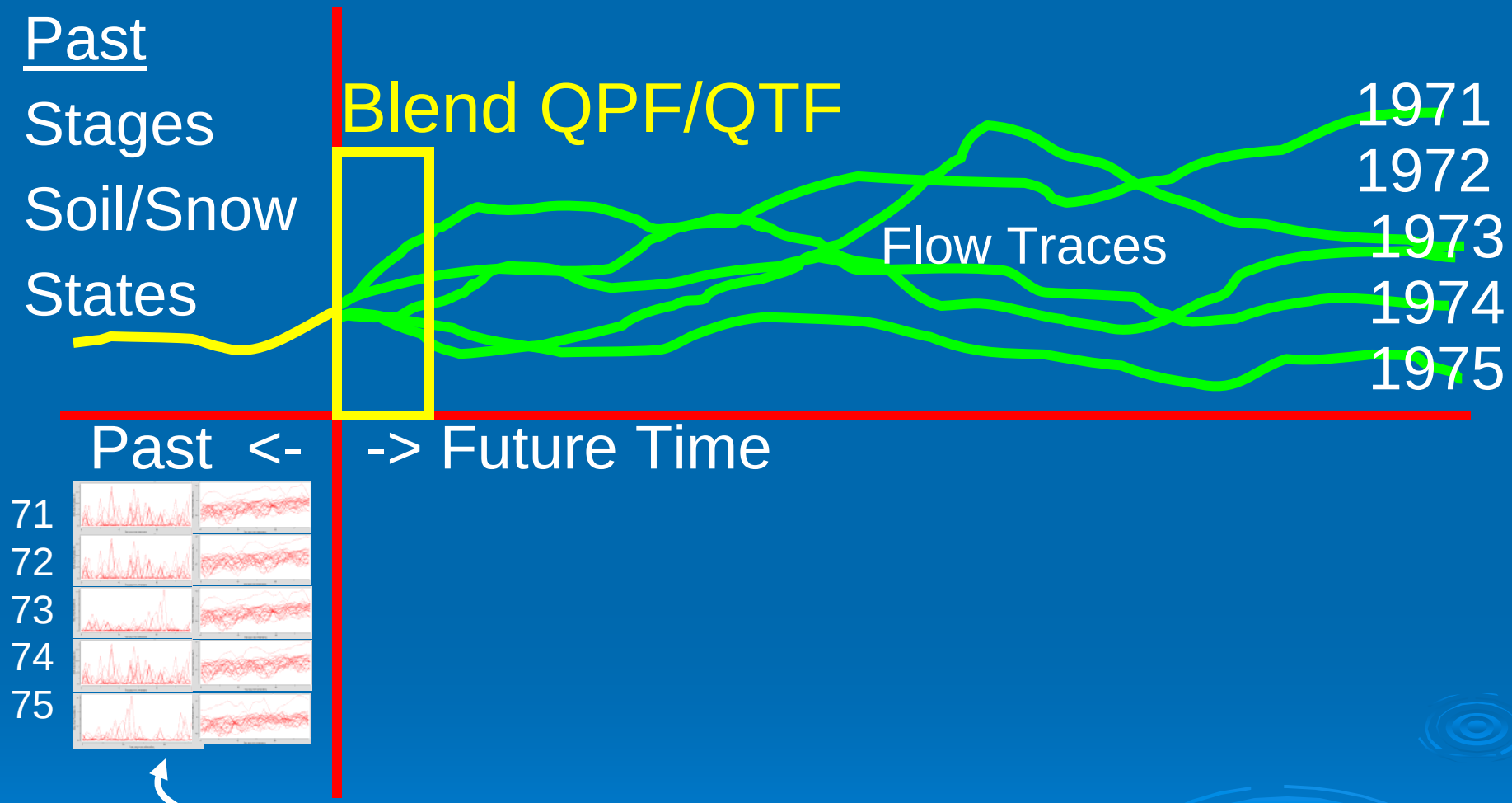
ESP

Continuous Modeling System
Produces Probabilistic Information
Accounts For All Drivers

(1) Historical Observations
(2) Initial Conditions – Antecedent/Soil Moisture
(3) Climate Variability
    Year Weighting Techniques
    a. Pre-Adjustment Inputs
    b. Post Adjustment Outputs
(4) Model Bias Correction

A SHORT PRIMER ON ESP

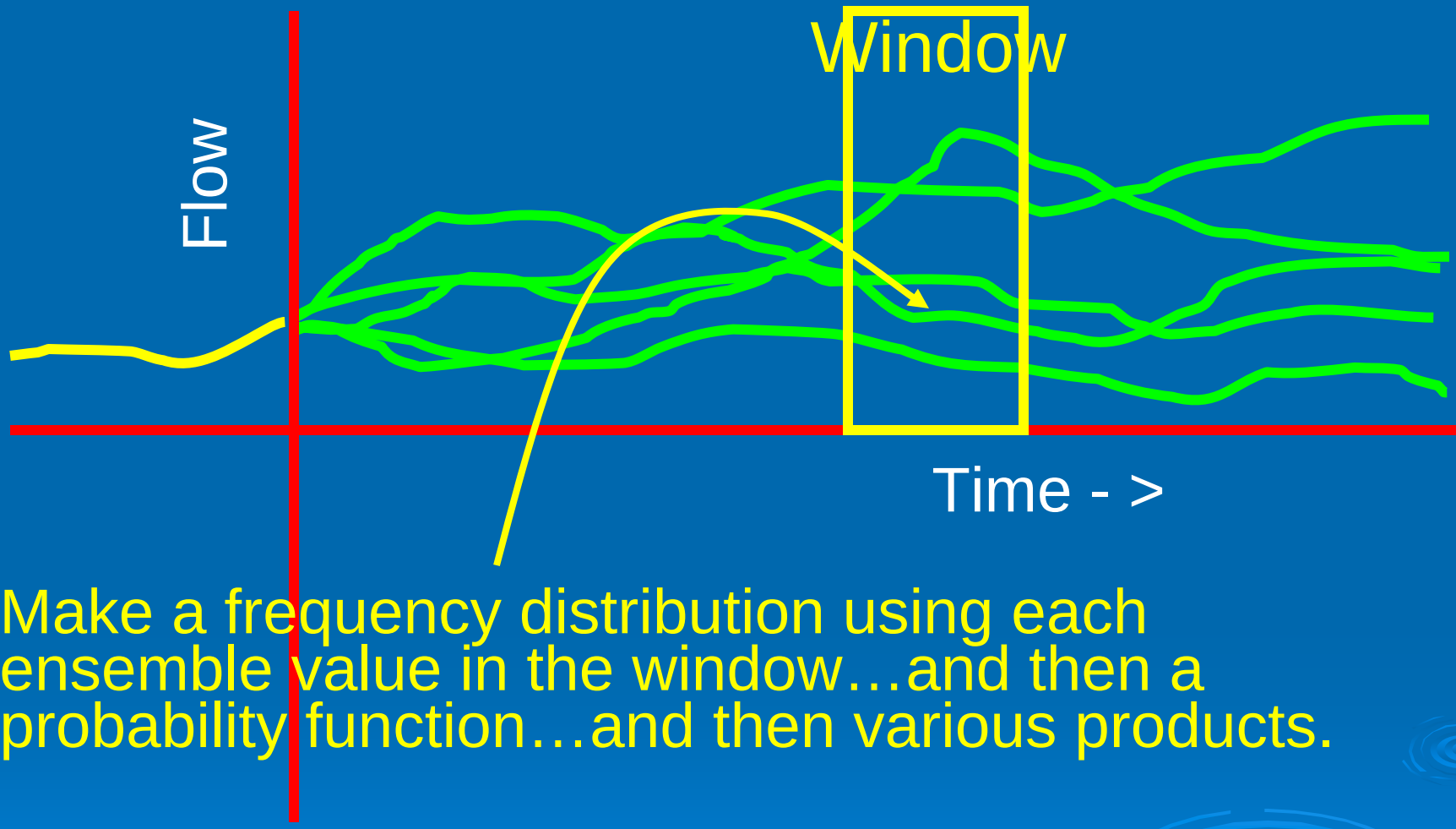
Making an Ensemble Forecast Using NWSRFS



Historical Precip/Temps for Past Years

Creates a Flow for Each Year

Making an Ensemble Forecast Using NWSRFS

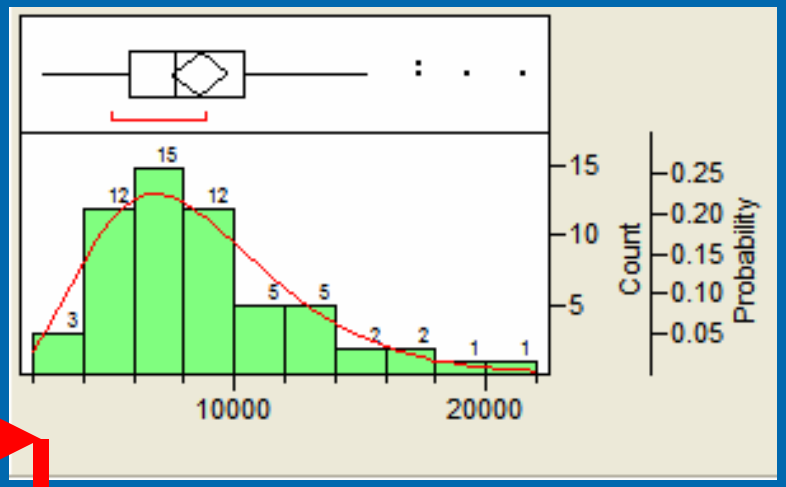


Elementary Probability Concept

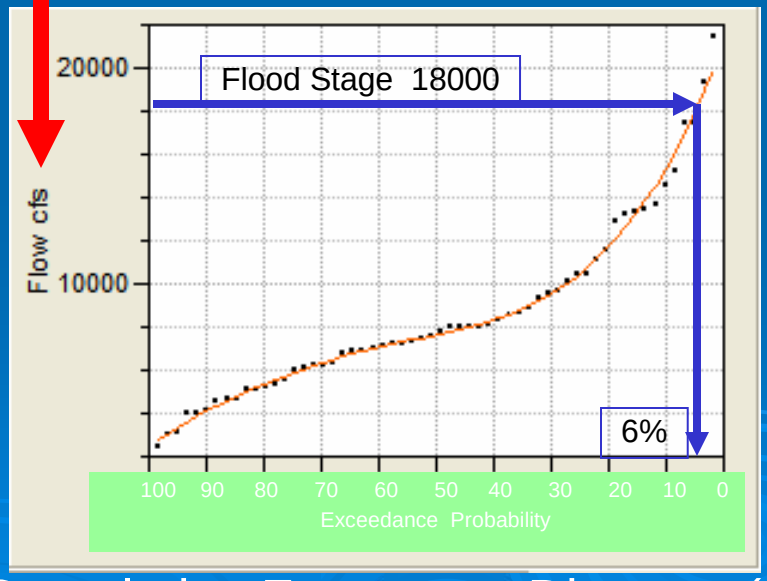
Raw Data
(Ensemble Members)

21500	8690	6240
19300	8600	6200
17400	8350	6100
17400	8110	5960
15200	8040	5590
14600	8040	5300
13700	8040	5250
13500	8040	5150
13300	7780	5140
13200	7600	4710
12900	7420	4680
11600	7380	4570
11100	7190	4110
10400	7190	4010
10400	7130	4010
10100	6970	3100
9640	6930	2990
9560	6870	2410
9310	6750	
8850	6350	

Window



Frequency Diagram (PDF)



Cumulative Frequency Diagram (CDF)

Initial Watershed Conditions

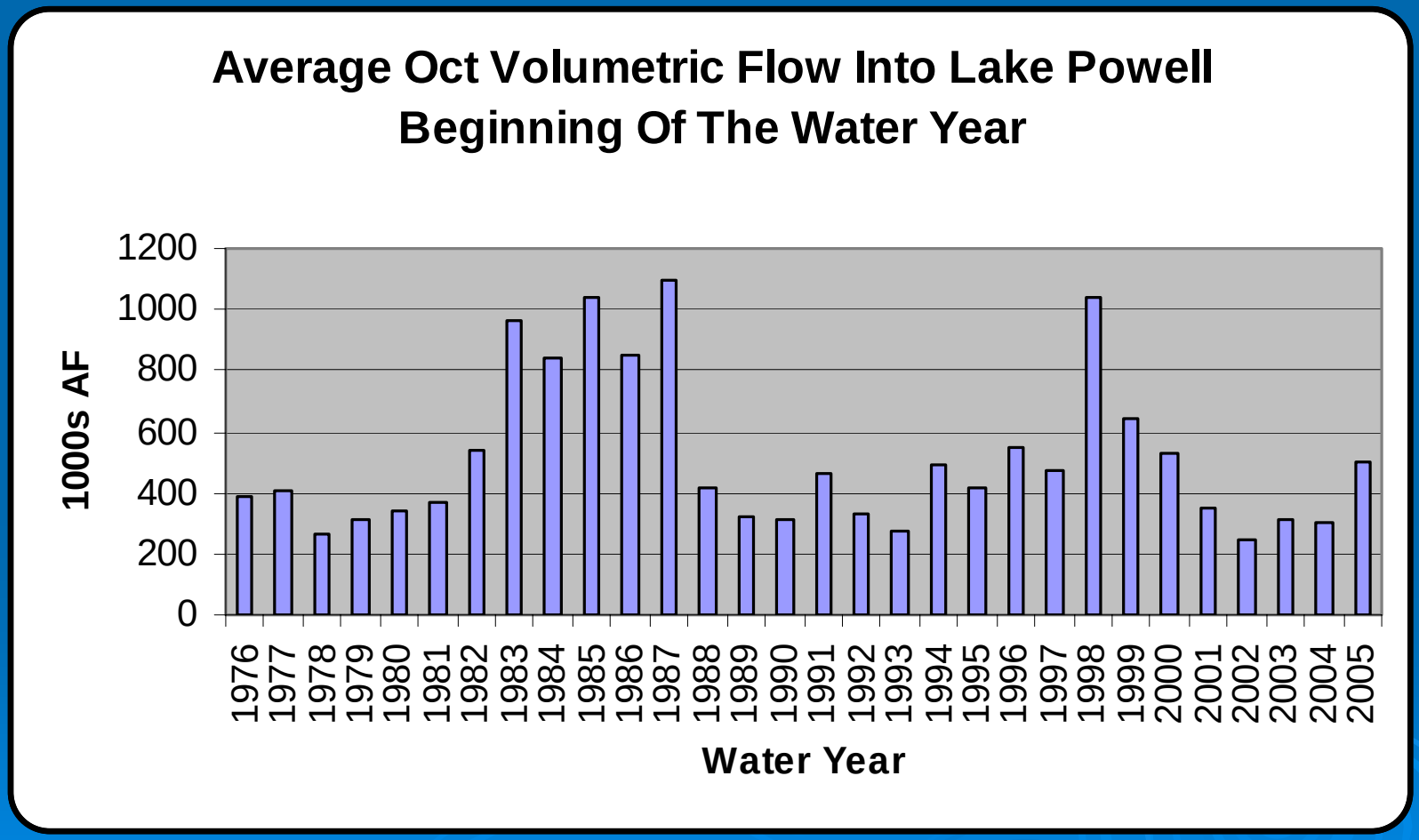
Antecedent Fall Flow
- Variable Between Seasons

Soil Moisture Surplus/Deficit
- Variable Between Seasons-Carryover

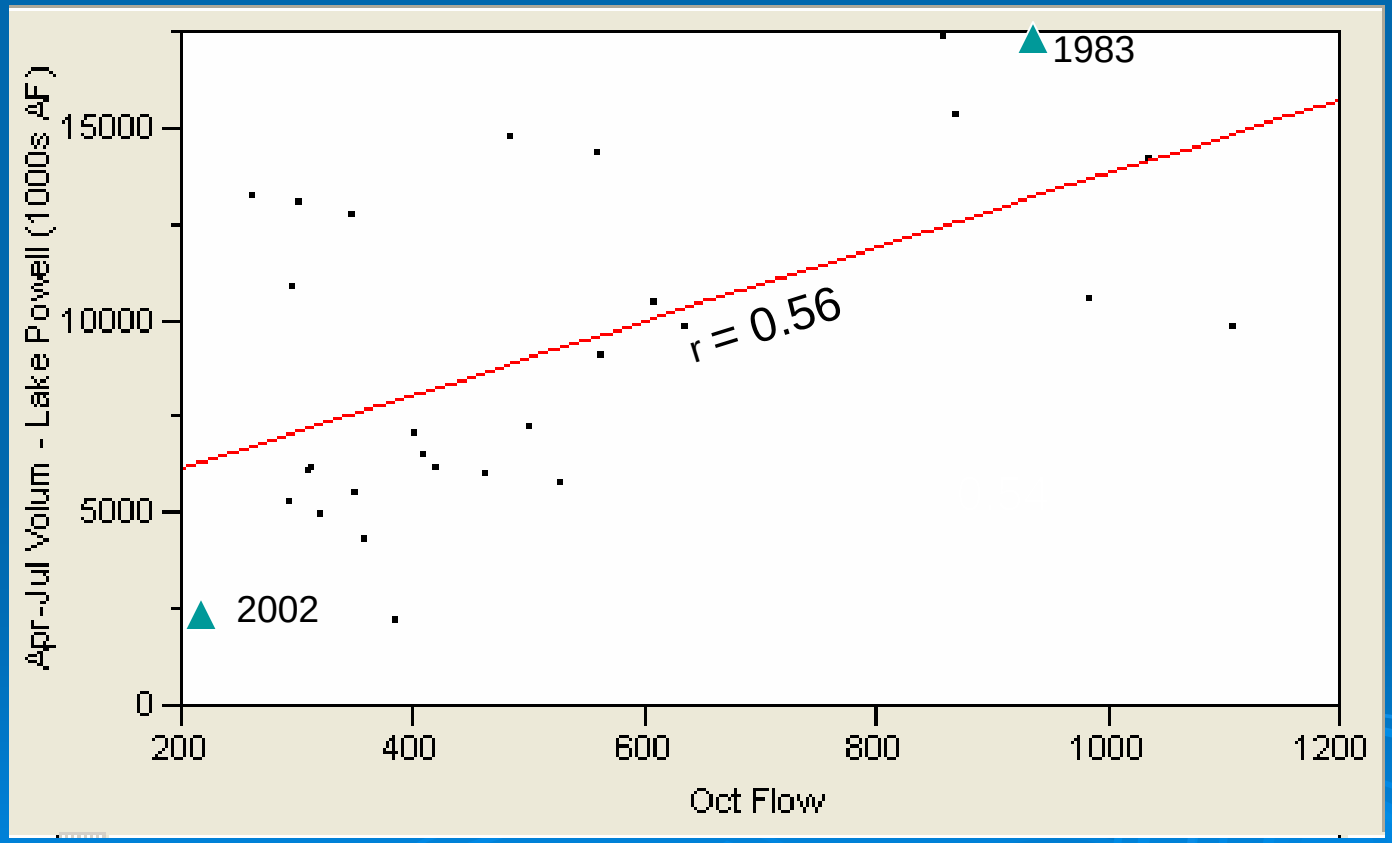
Snow Pack
- Usually Small on Nov 1

Reservoir Conditions
- Not considered in unregulated mode

Initial Watershed Conditions
Antecedent Fall Flow



Correlation-October Streamflow And Apr-Jul Volume Runoff-Lake Powell (1976 – 2004)



Initial Watershed Conditions

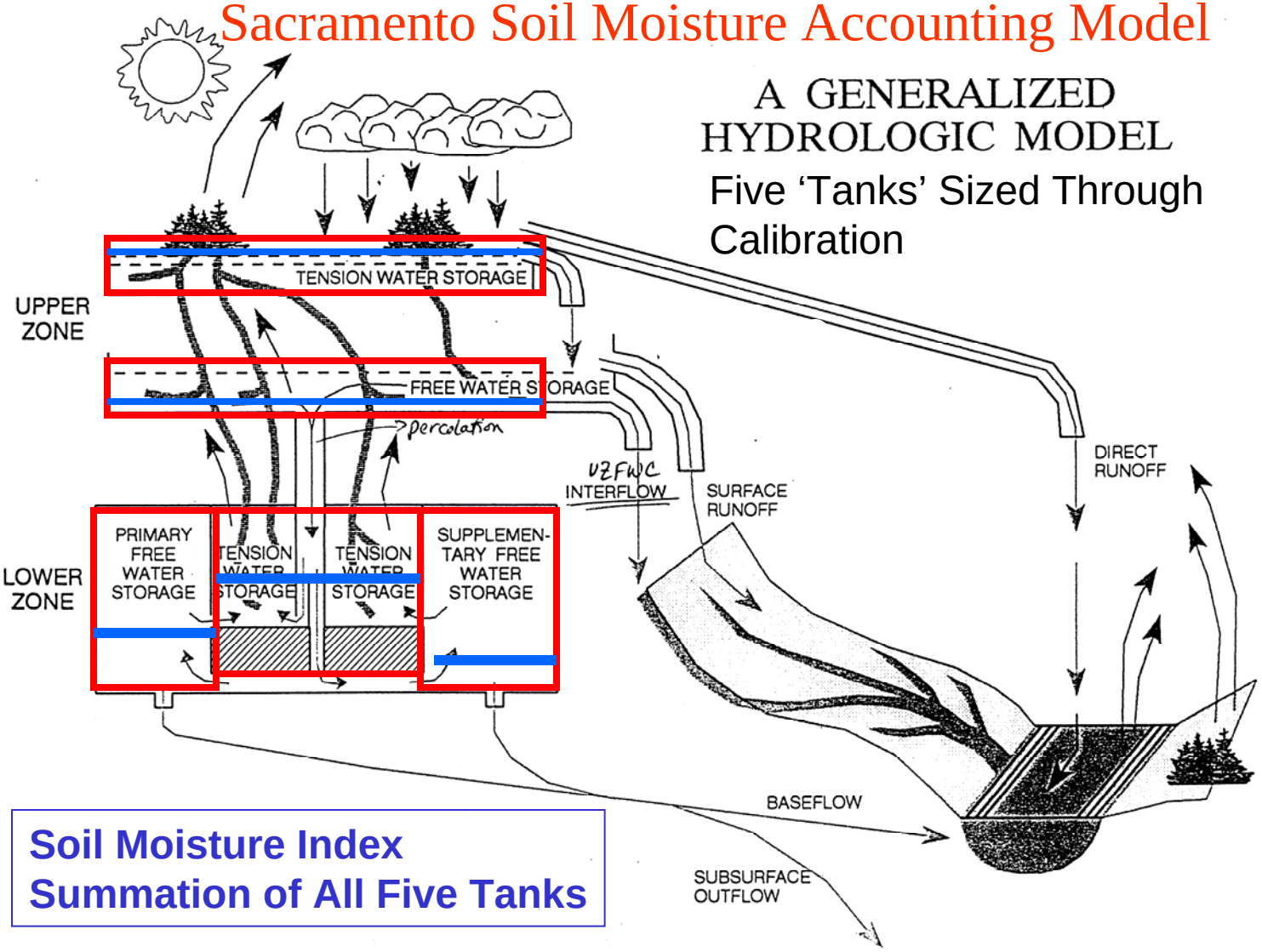
Soil Moisture Conditions

No Basin Wide/Historical Soil Moisture Network

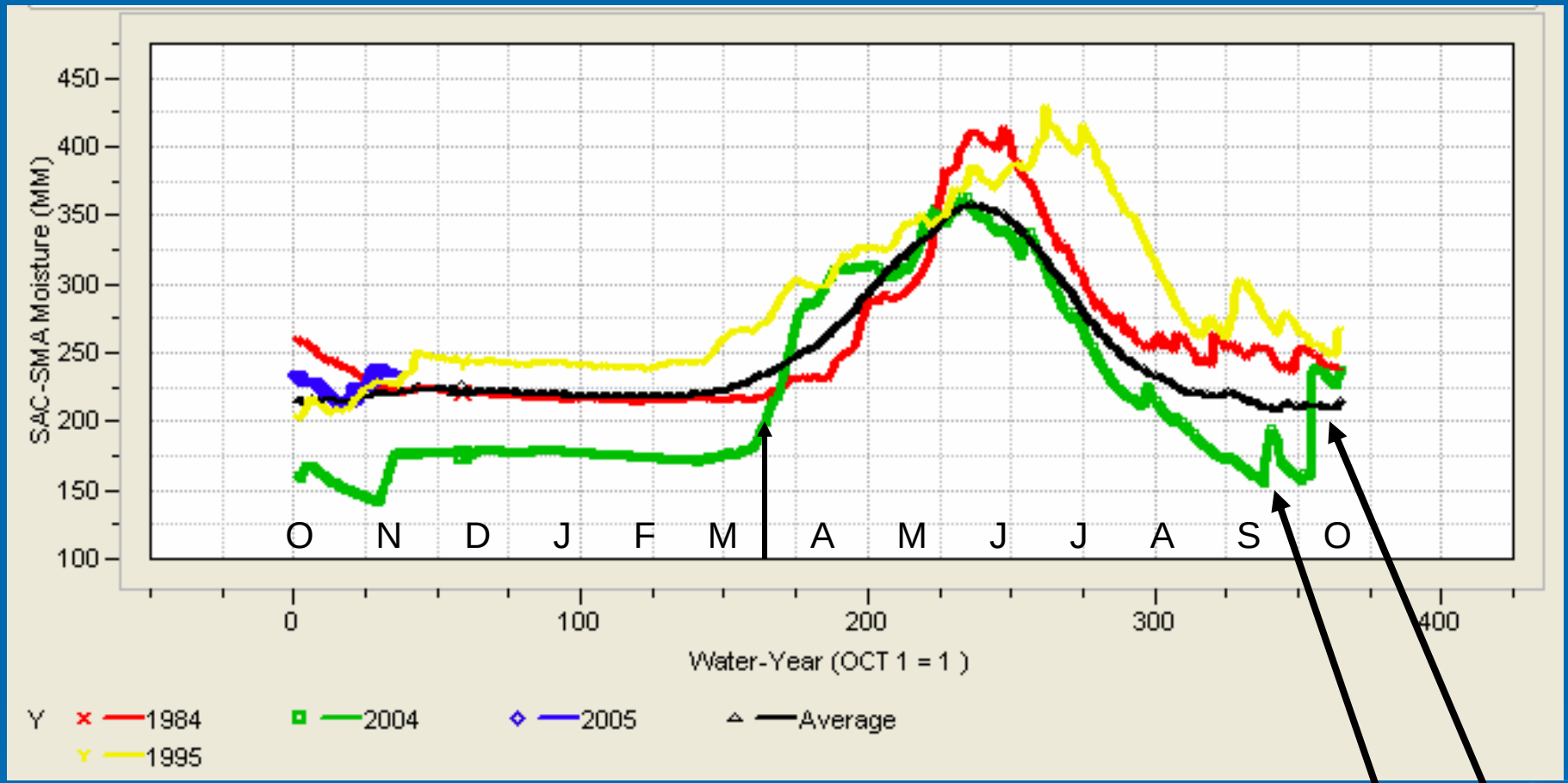
ESP-Soil Moisture Accounting Model

Sacramento Soil Moisture Accounting Model

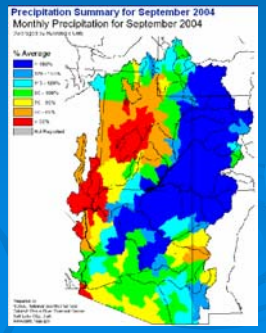
Sacramento Soil Moisture Accounting Model

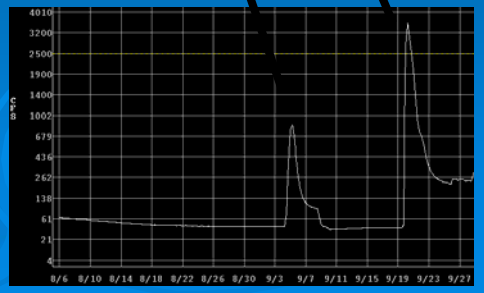


Soil Moisture Index
Summation of All Five Tanks

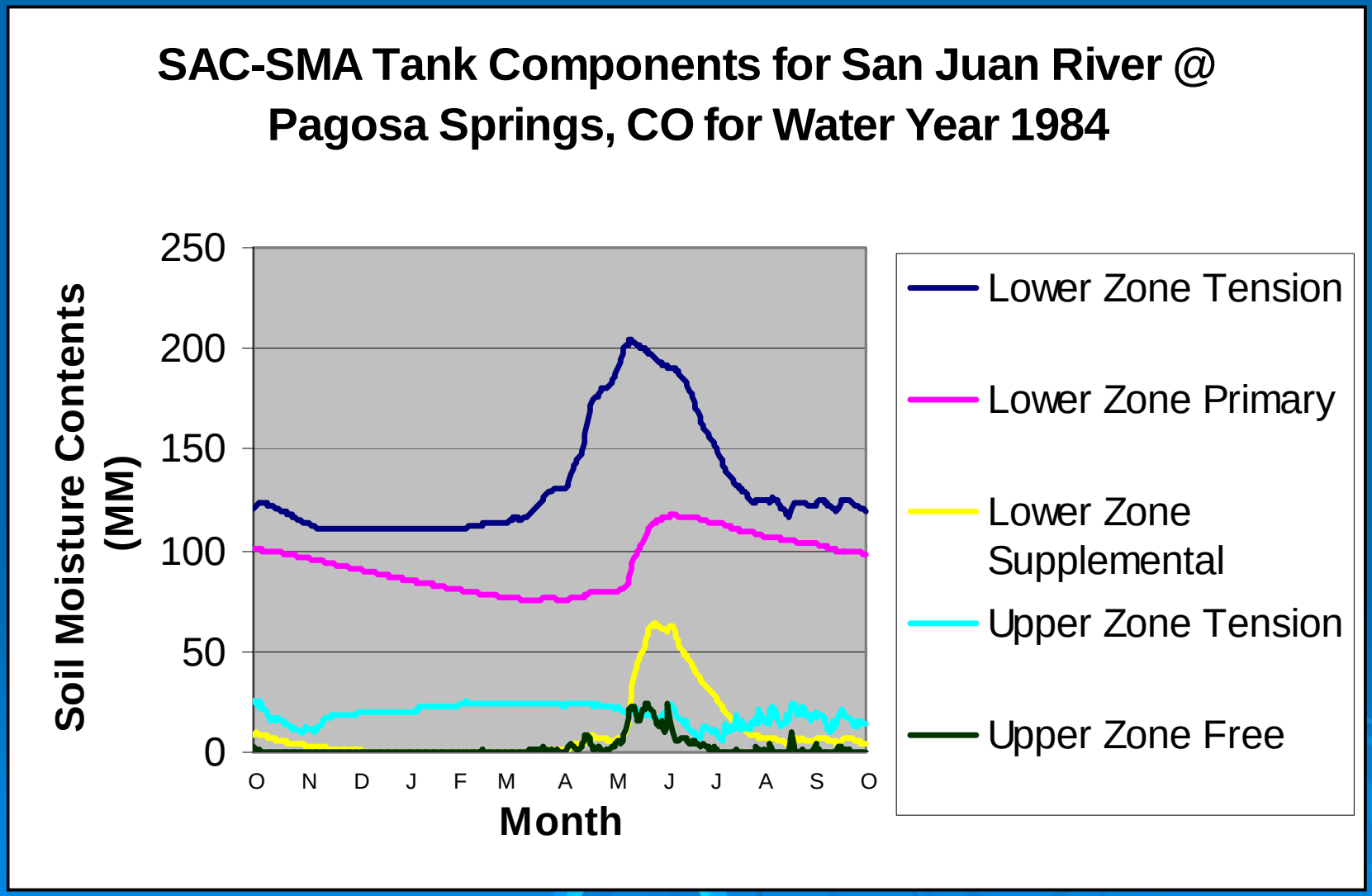


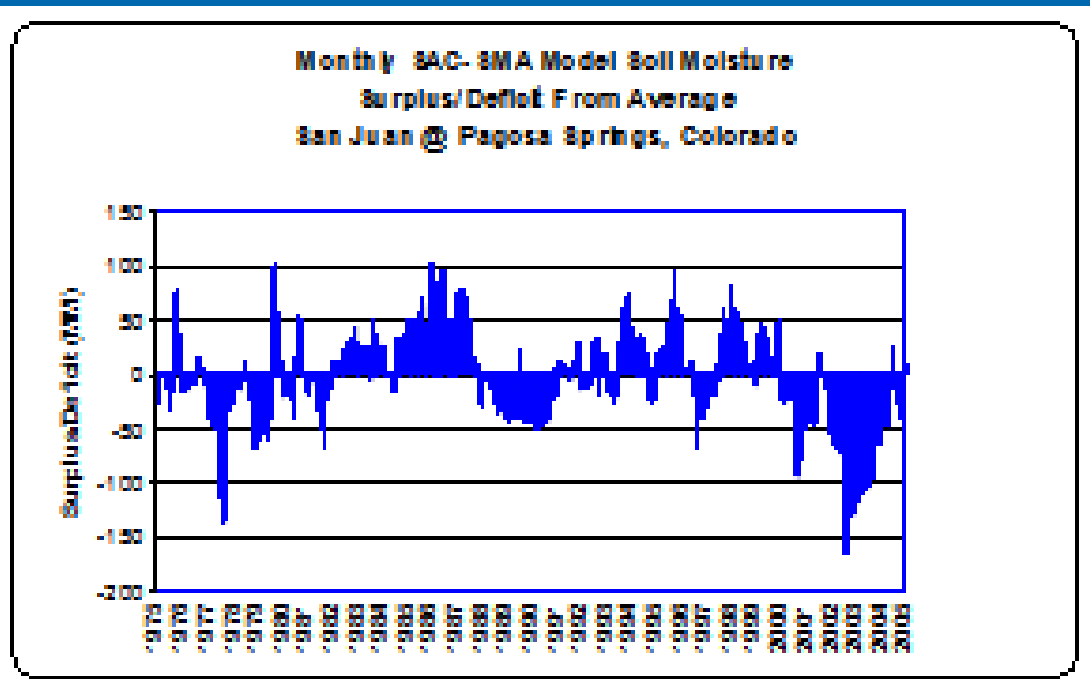
SAC-SMA Soil Moisture Index
San Juan River @ Pagosa Springs, CO

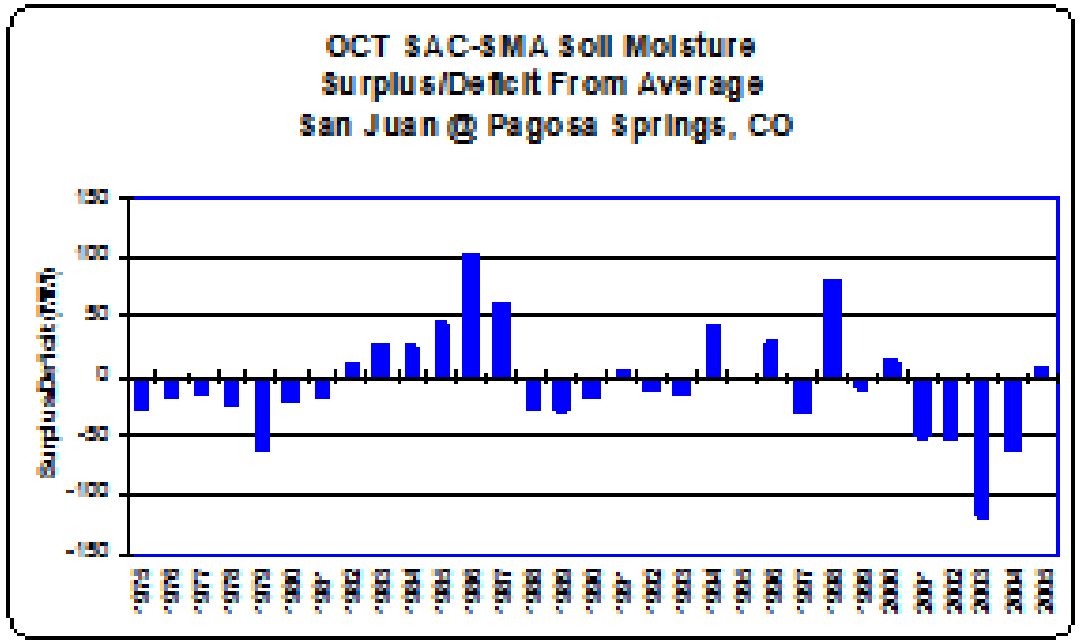




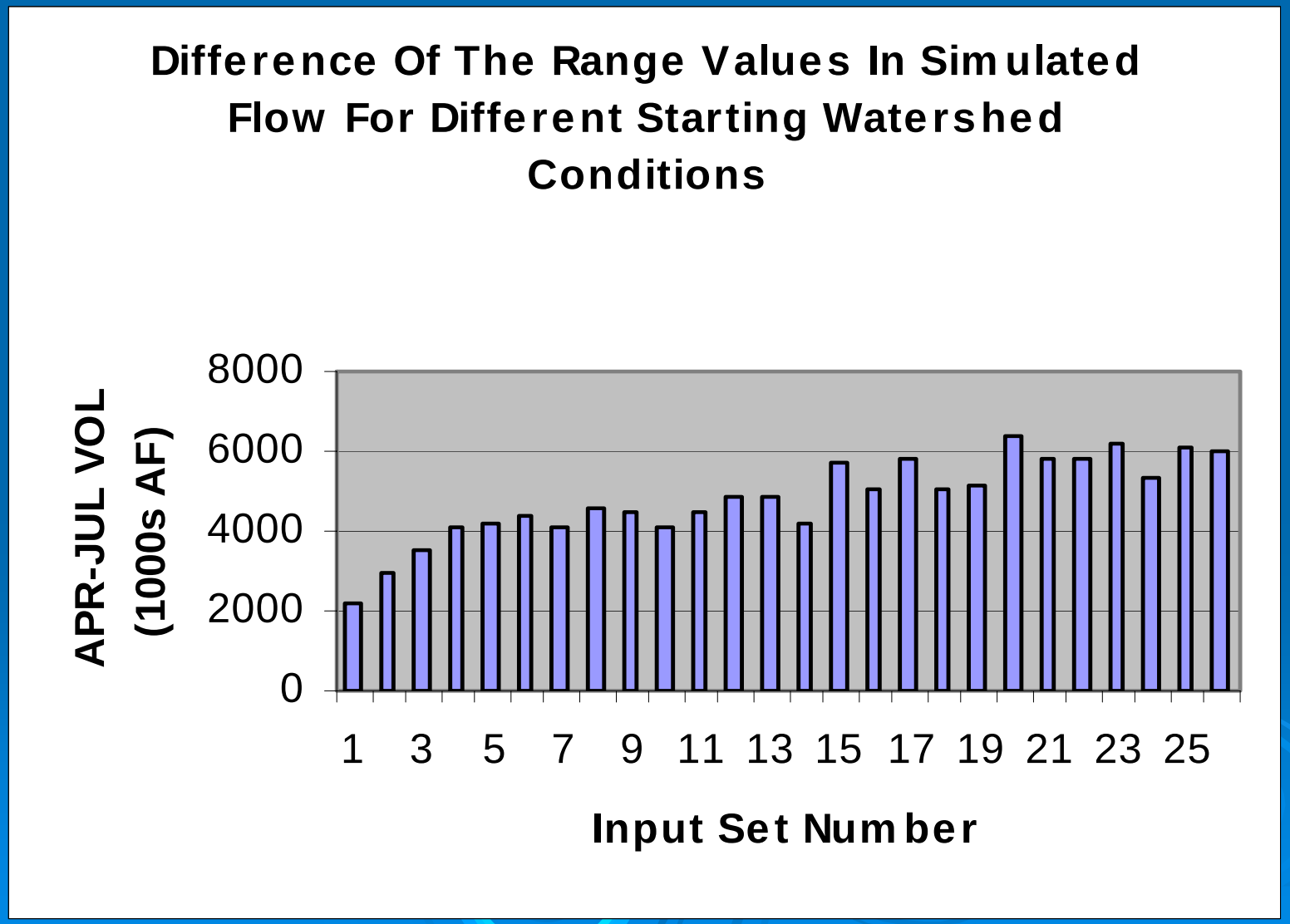
Initial Watershed Conditions
Soil Moisture Conditions




Monthly SAC-SMA Model Soil Moisture
Surplus/Deficit From Average
San Juan @ Pagosa Springs, Colorado
150
100
50
0
-50
-100
-150
-200

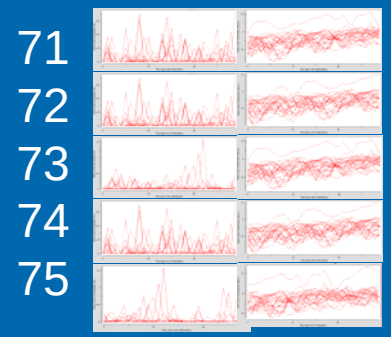

OCT SAC-SMA Soil Moisture
Surplus/Deficit From Average
San Juan @ Pagosa Springs, CO
150
100
50
0
-50
-100
-150

Initial Watershed Conditions
Soil Moisture Conditions

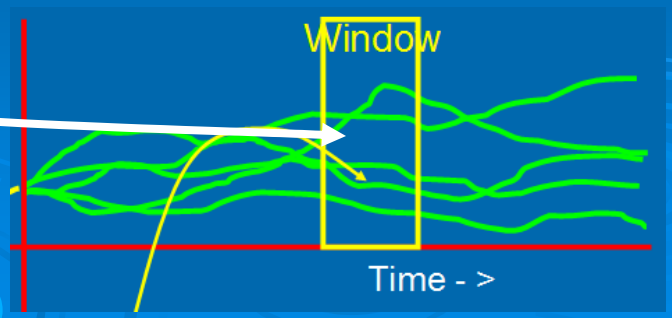


Climate Variability-ESP

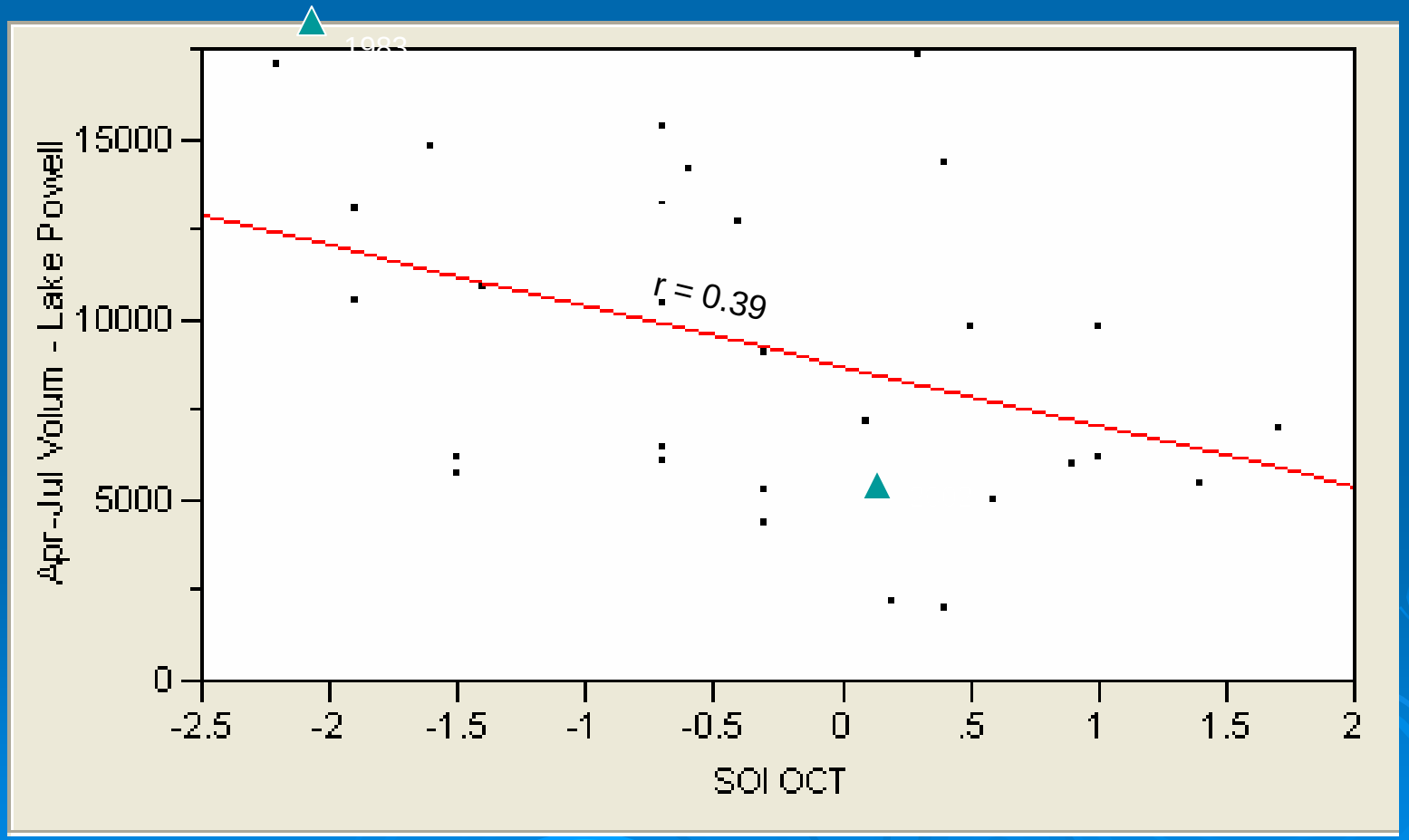
Pre -Adjustment Technique
Weight/Modify on Input Side



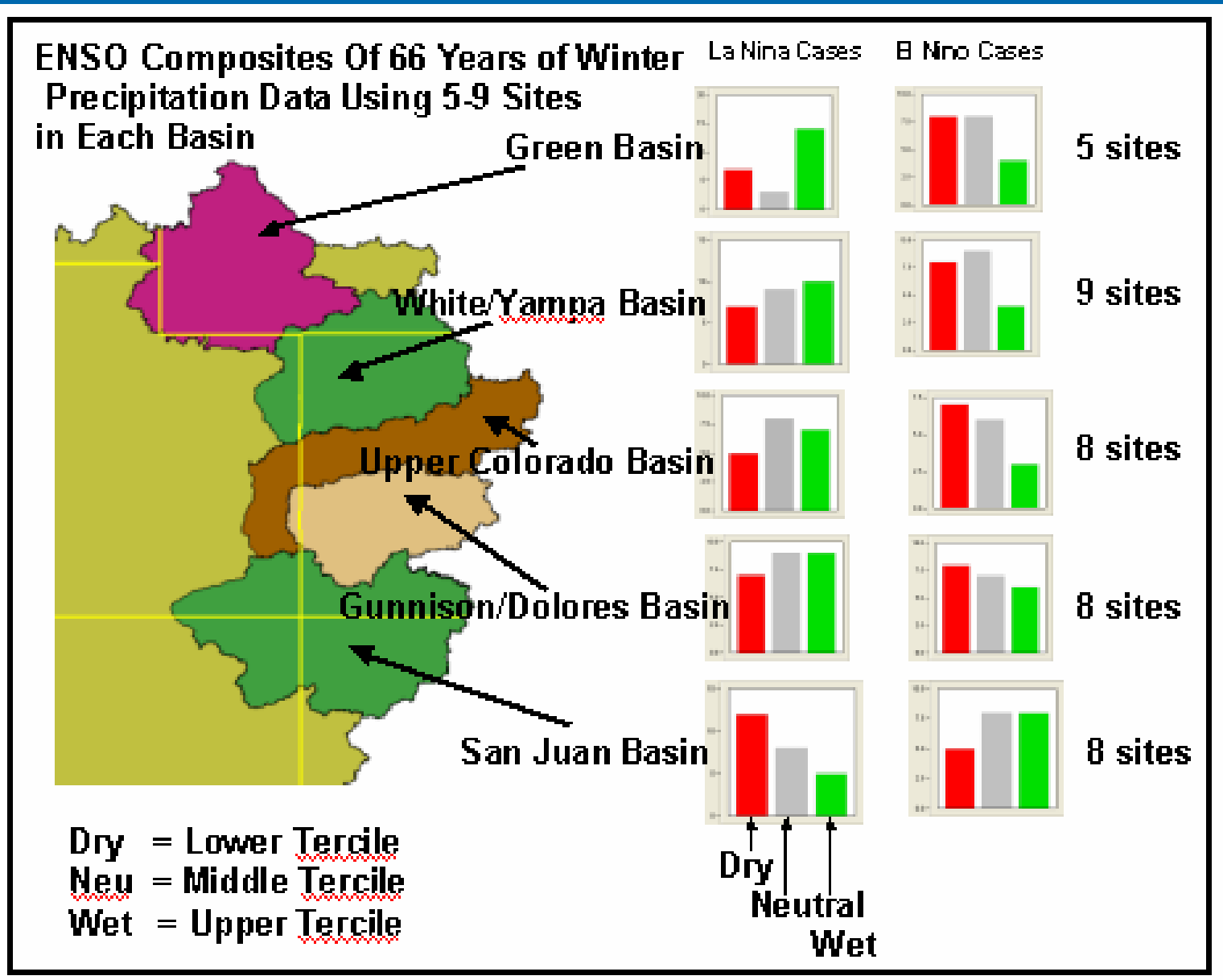
Post -Adjustment Technique
Weight On Output Side



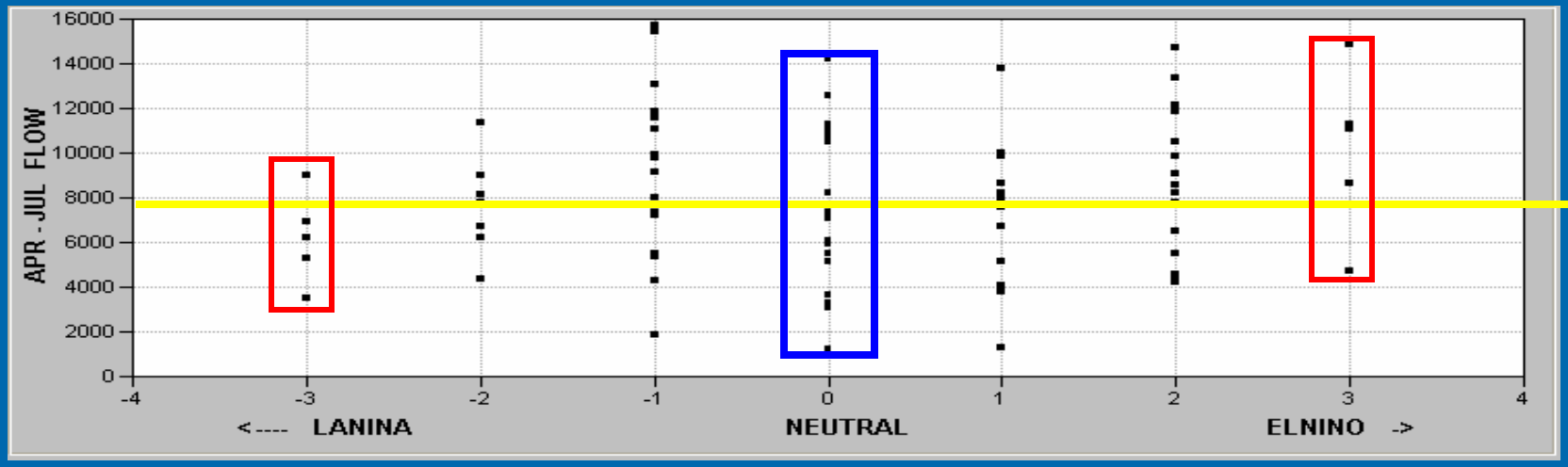
Correlation Between SOI In October And Following Apr-Jul Volume Runoff-Lake Powell (1976 – 2004)



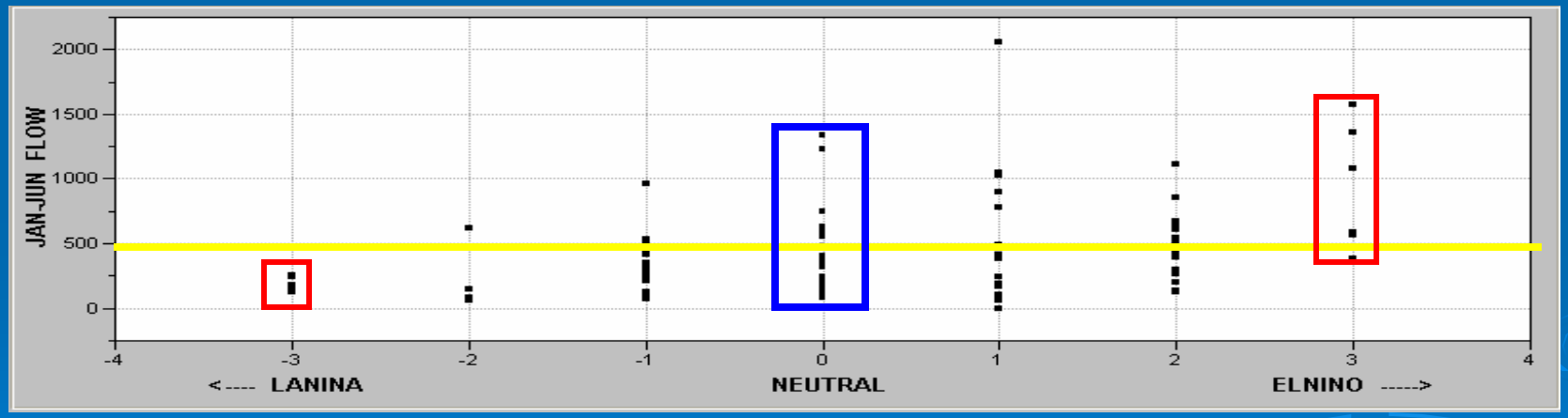
ONI Composites In Upper Colorado



Upper Colorado – Lake Powell Inflow



Lower Colorado – Salt River Inflow



Oct/Nov/Dec Sea Surface Temperature Analysis 150 West to Date Line

Strong Warm(+3) /Cool Periods (-3)
Moderate Warm(+2)/Cool Periods (-2)
Weak Warm(+1)/Cool Periods (-1)
Neutral (0)

Summary

ESP Accounts for the Main Drivers

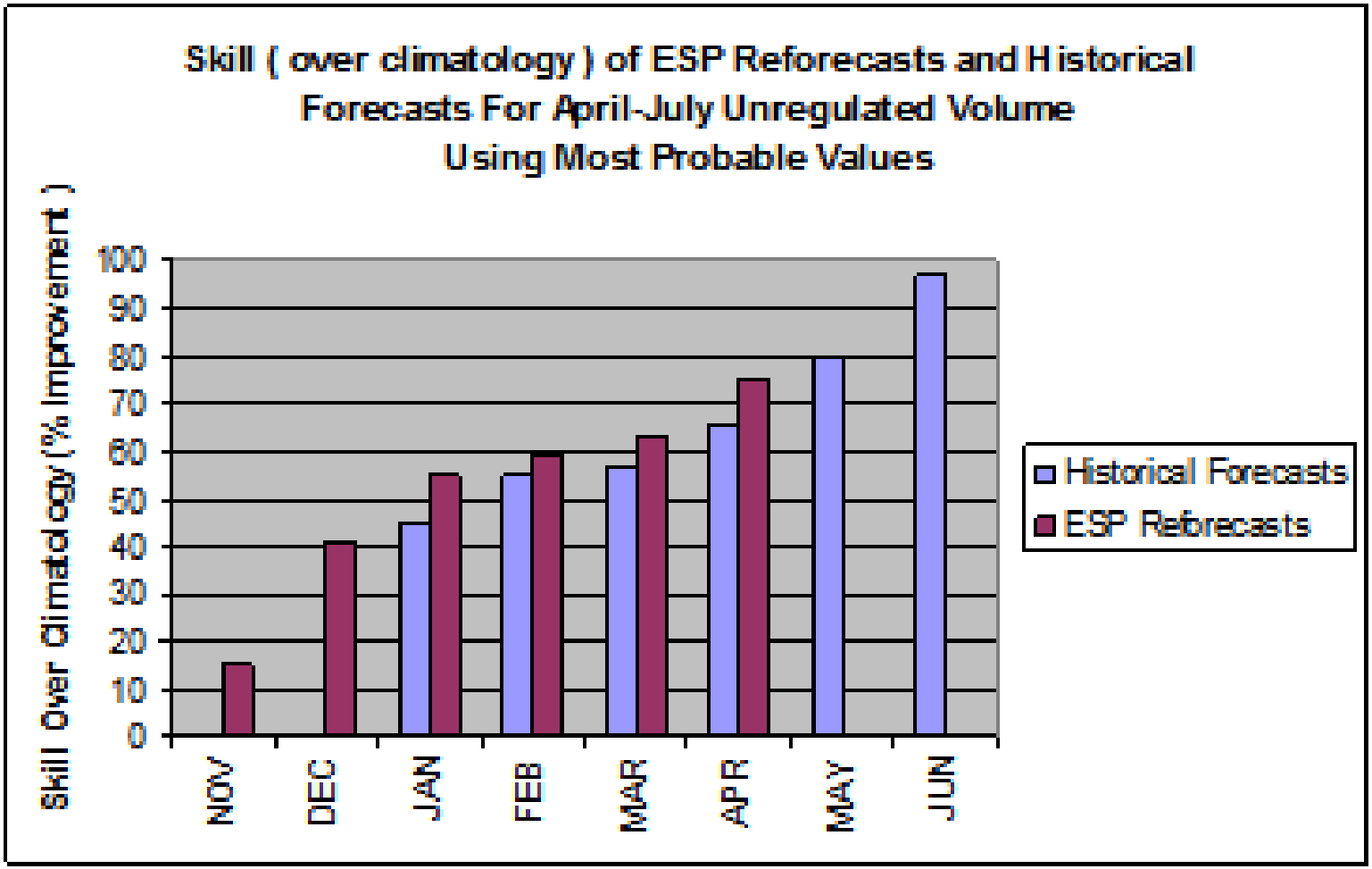
1. Historical Climatology
2. Initial Watershed Conditions
3. Climate Variability
4. Model Bias

Reforecasting Using ESP

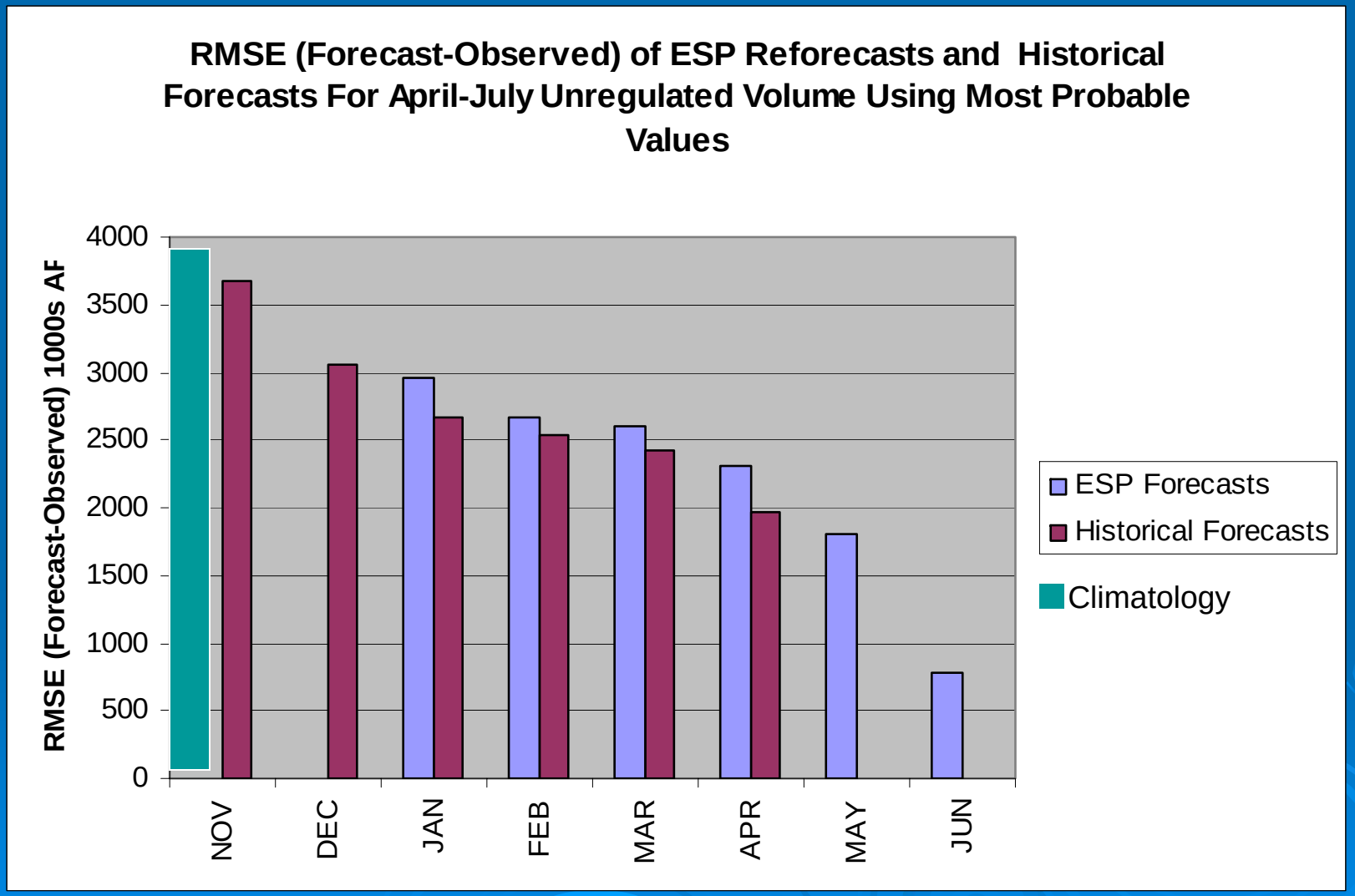
Reforecasting =
Jackknifing =
Cross Validation

Run ESP For Every Year
…BUT…
Throw Out the Year in Question

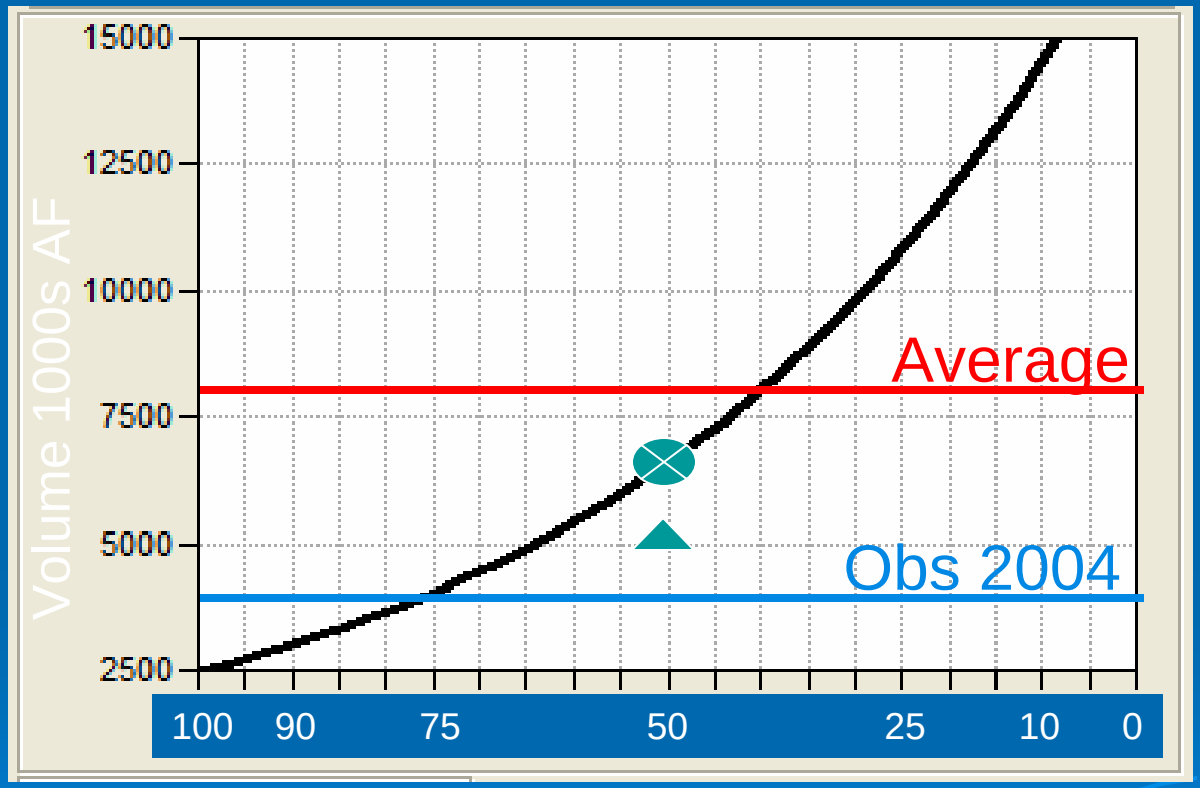
ESP Reforecasting



ESP Reforecasting



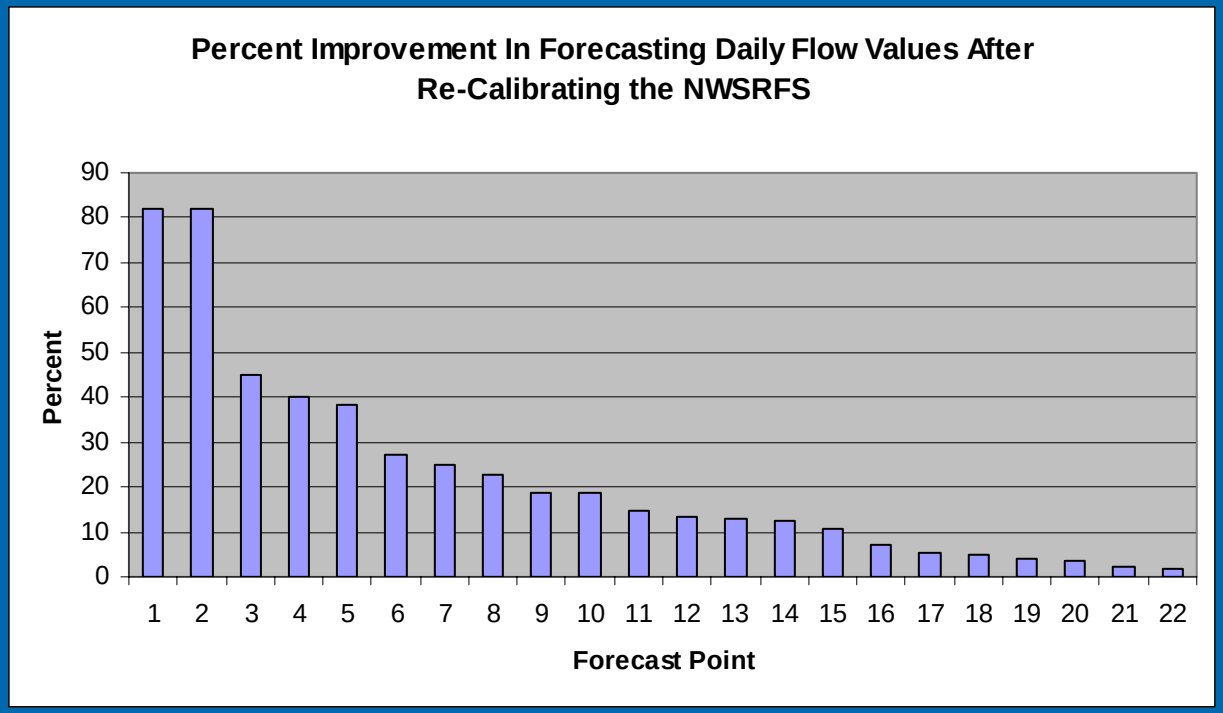
ESP Forecast For Lake Powell
April-July 2005 Volume
Made November 3, 2004



Forecast of Most Probable Made on Aug 18 2004 (5100)

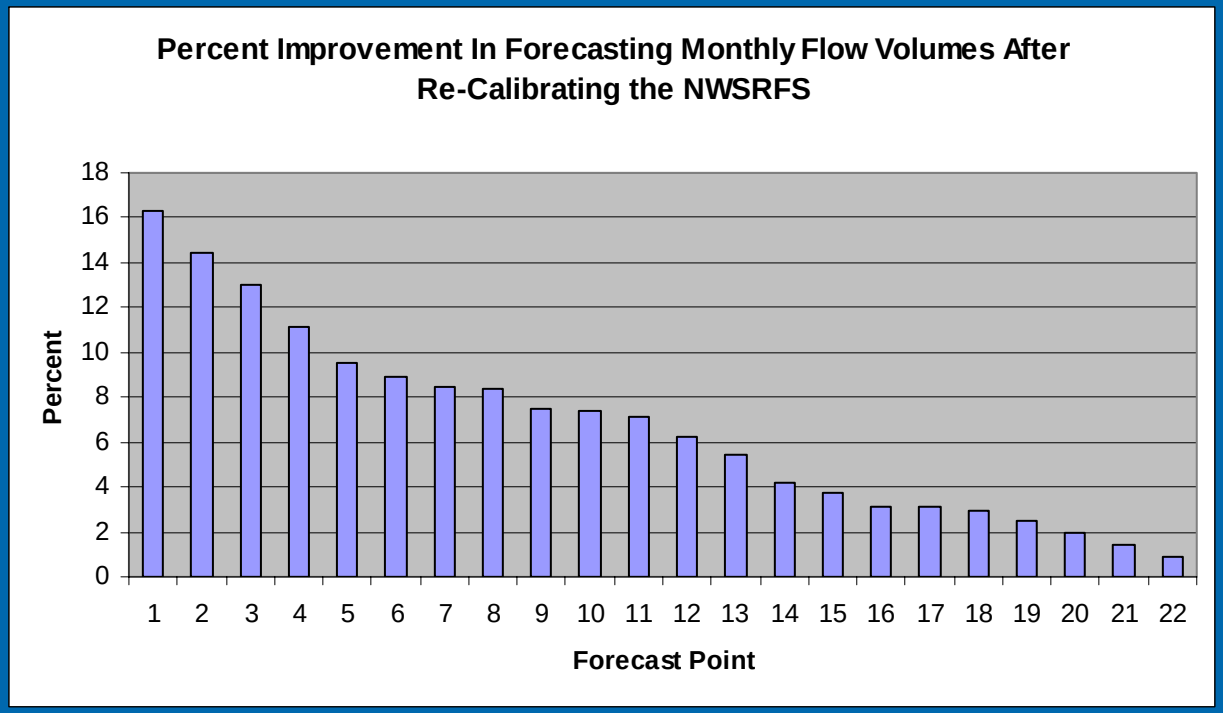
Forecast of Most Probable Made on Nov 3 2004 (6700)

The End



Forecast Points From

Wyoming:	**1,3,18**
Colorado:	**5,6,7,8,10,11,12,14,15,16,20,22,23**
Arizona:	**9,17,19,21**
Utah:	**2,4,13**



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