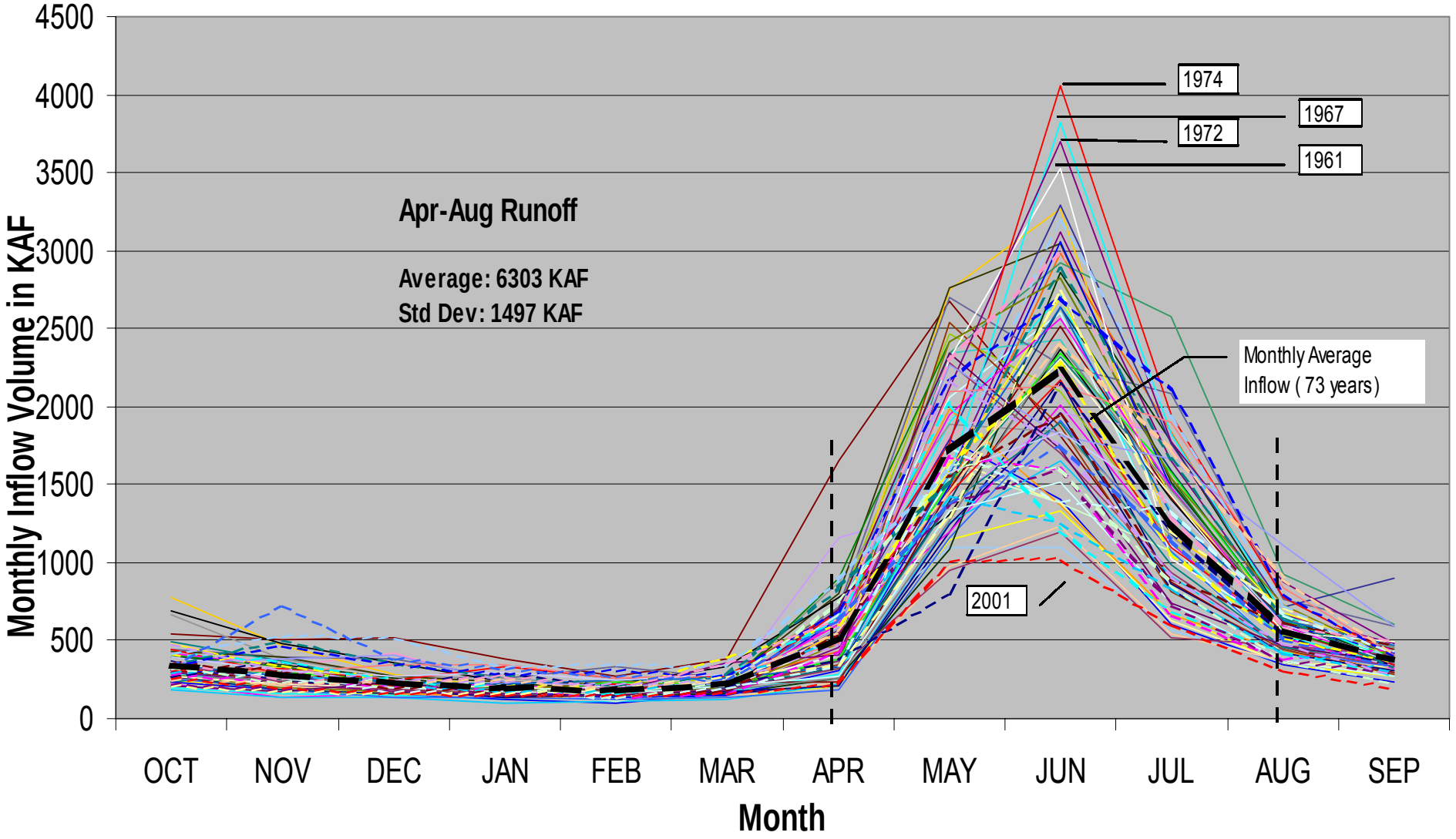
Update of Libby Statistical Forecast Procedure to Improve Early Season Forecasts

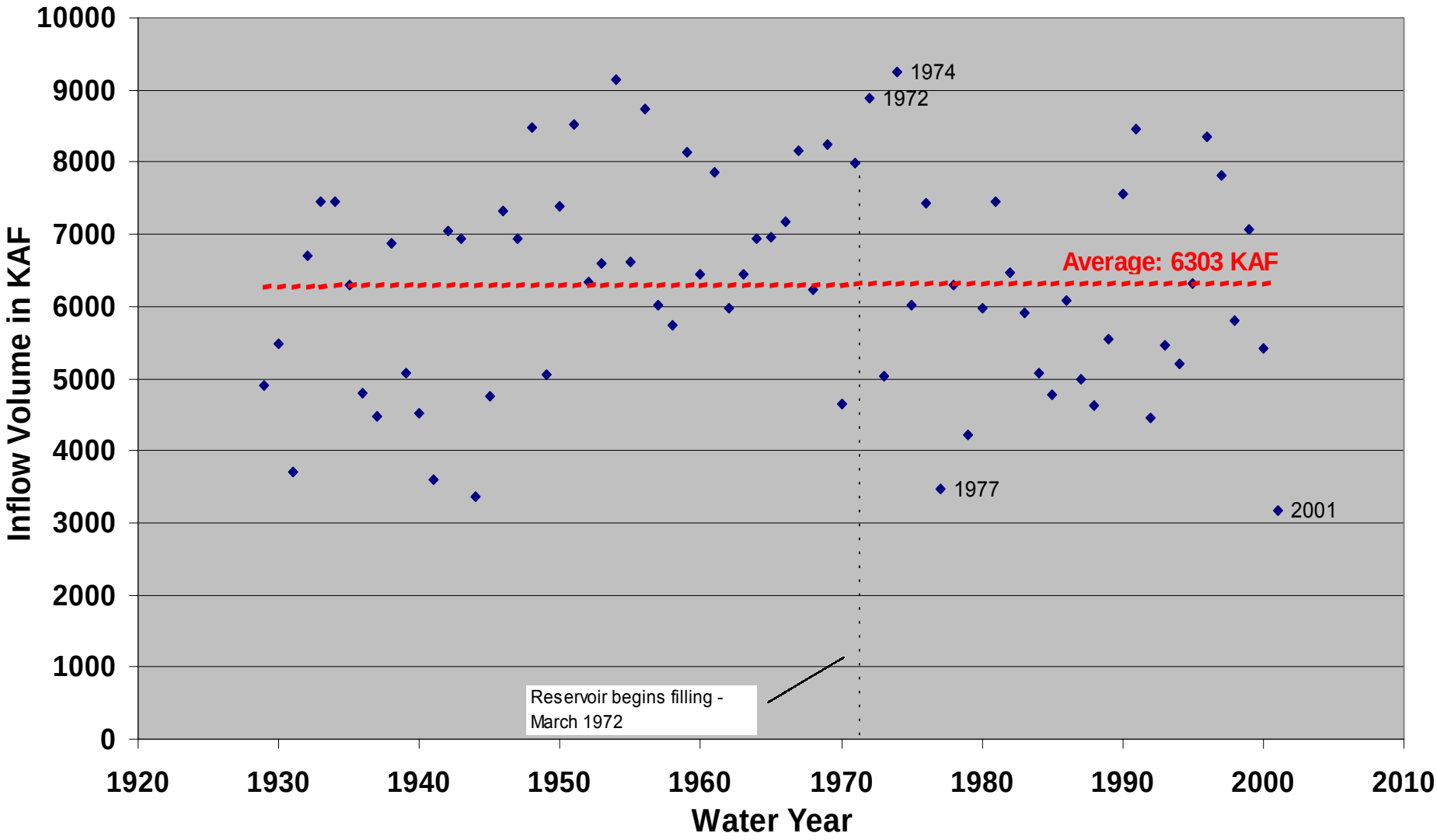
Randy Wortman

Sept 25, 2002

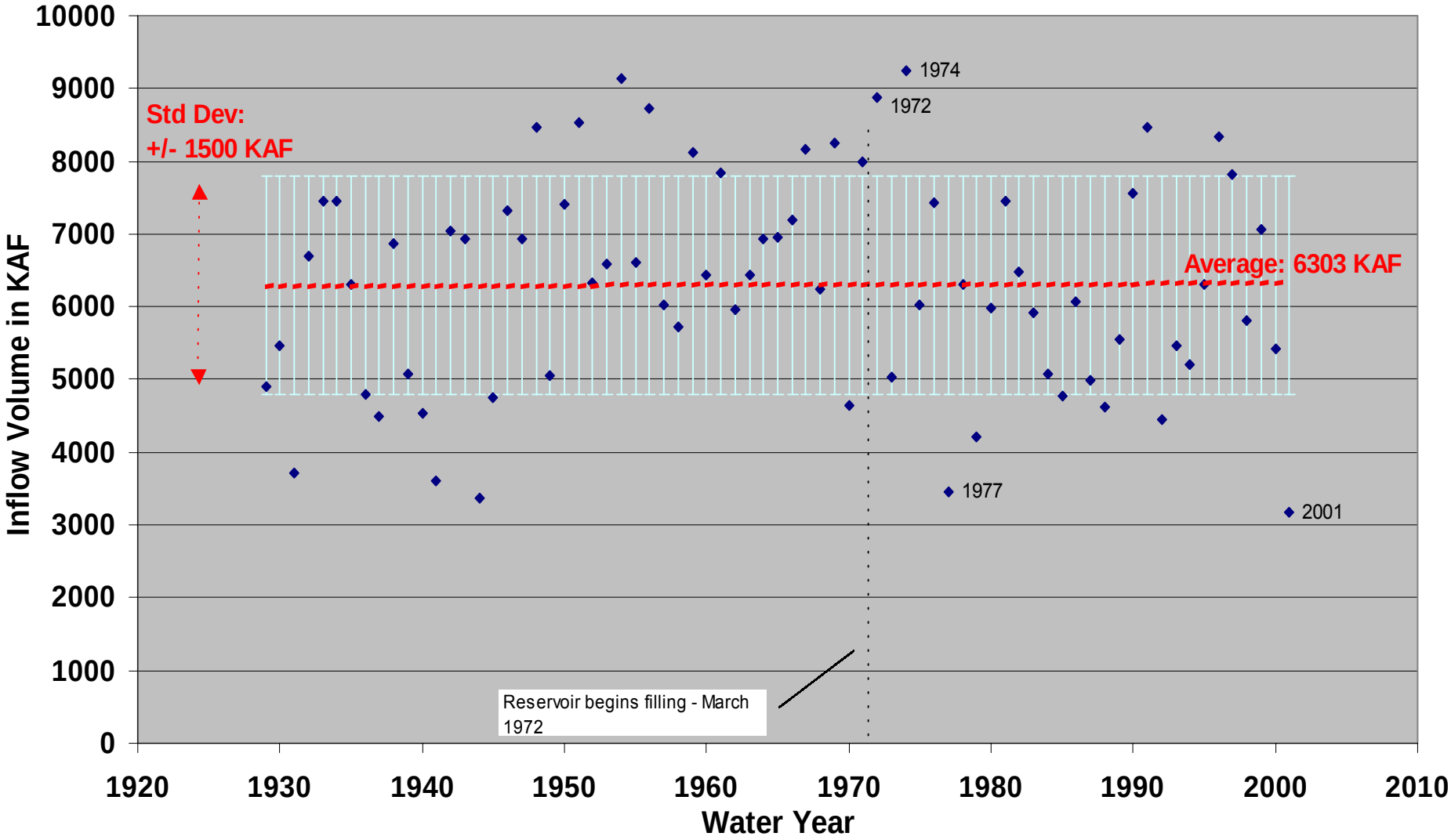
Historic Libby Inflow 1929-2001



Historic Apr-Aug Runoff 1929-2001

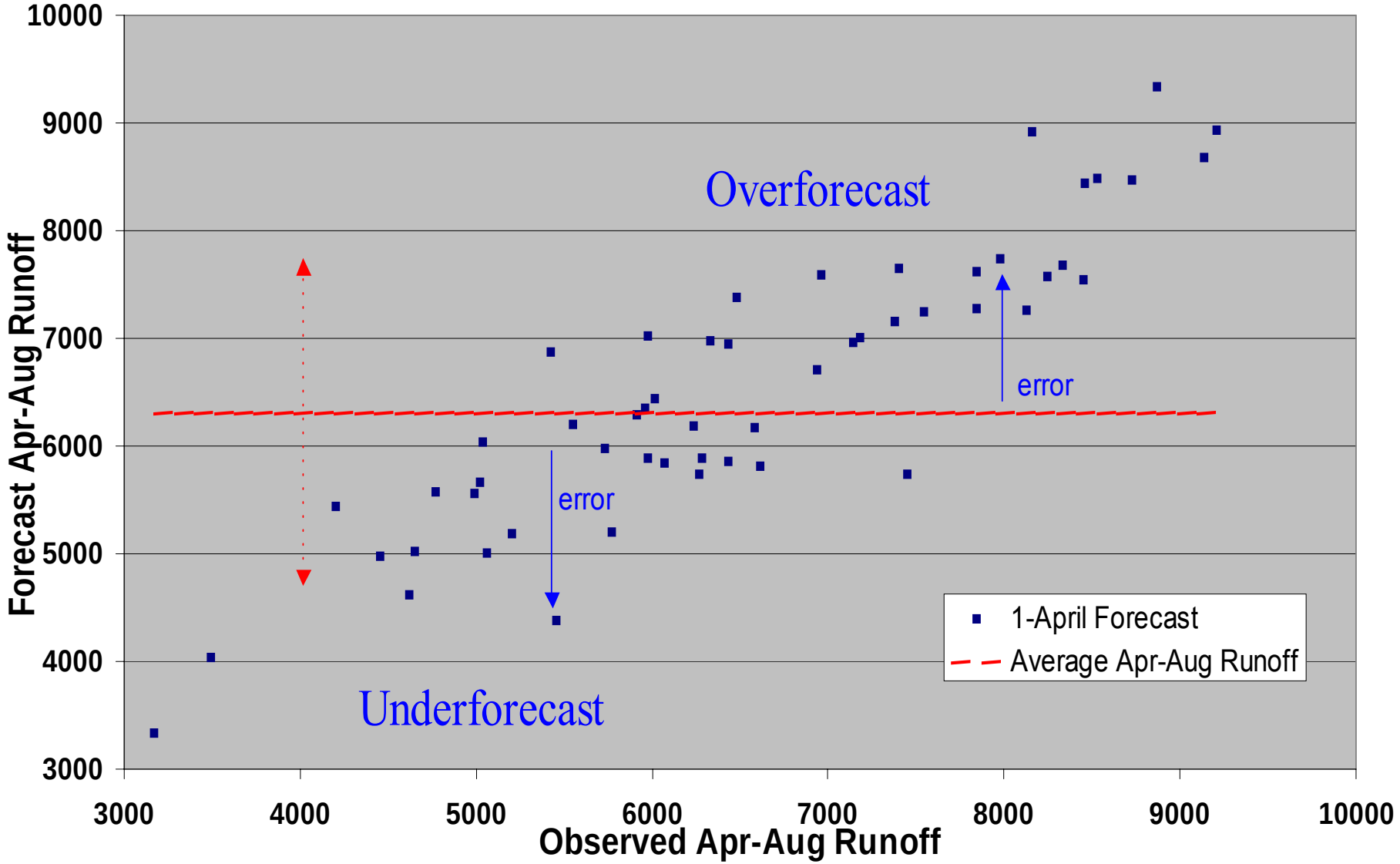


Historic Libby Apr-Aug Runoff



Libby Forecast Performance

1 April Forecast (Forecast = Average)



Current Libby Forecast Model Equations

Fort Steele Regression Model

1.309 FRO + 0.067 SWE + 0.068 WP + 0.167 SP – 5.114

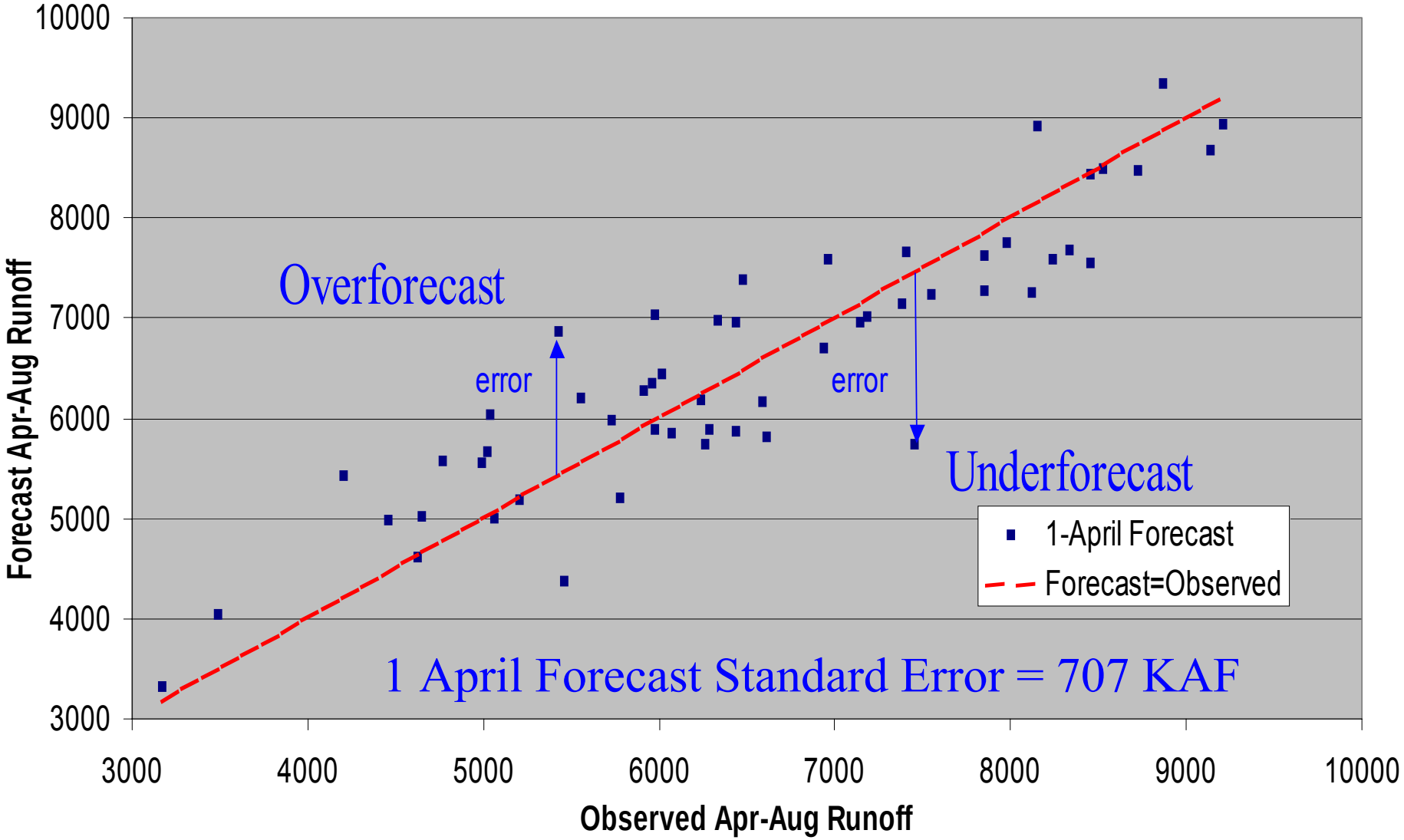
R^2=.914 Std Error=213 KAF

Libby Local Regression Model

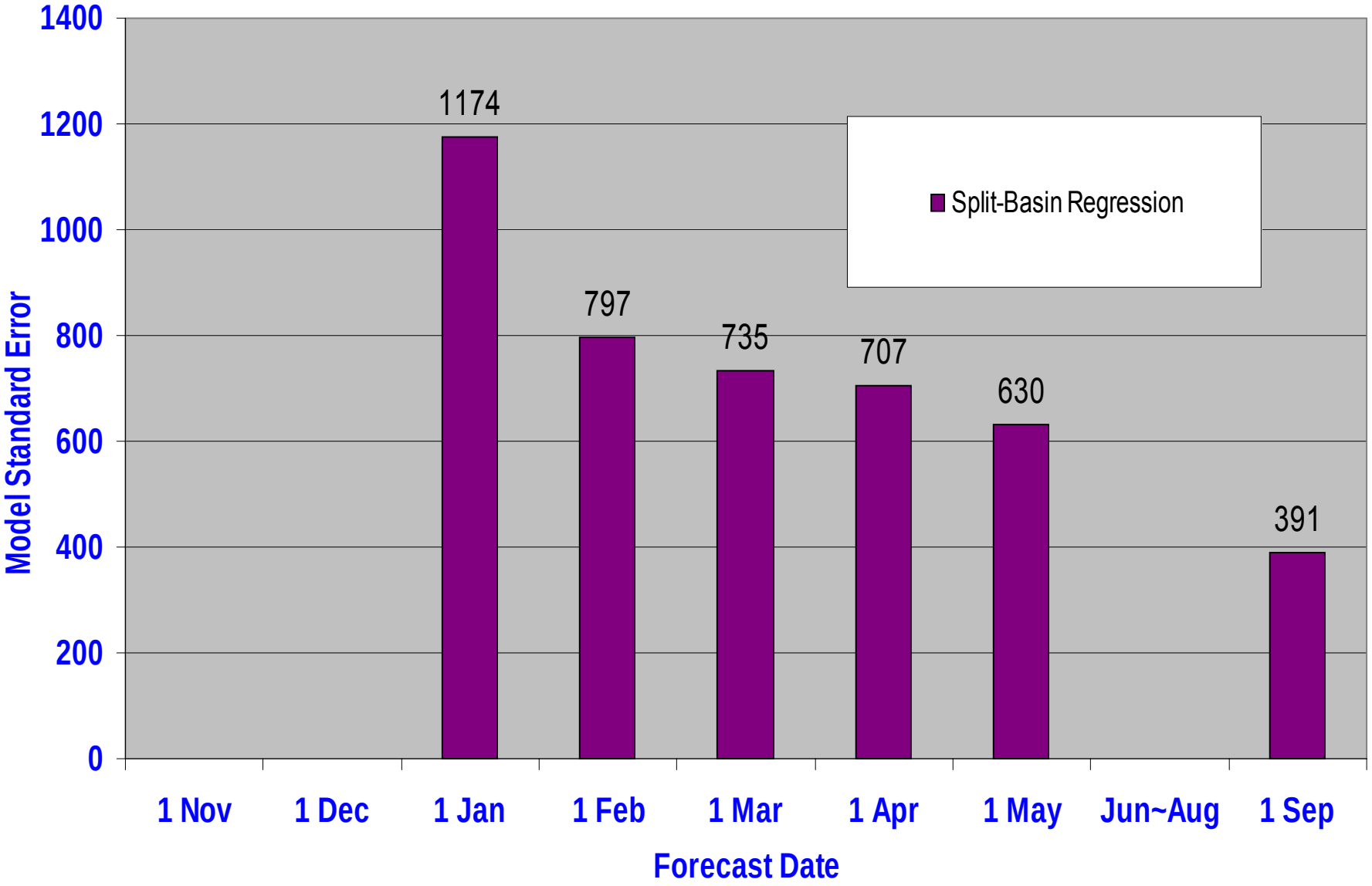
0.921 FRO + 0.046 SWE + 0.086 WP + 0.152 SP – 4.183

R^2=.874 Std Error=262 KAF

Libby Forecast Performance
– 1 April Split-Basin Regression



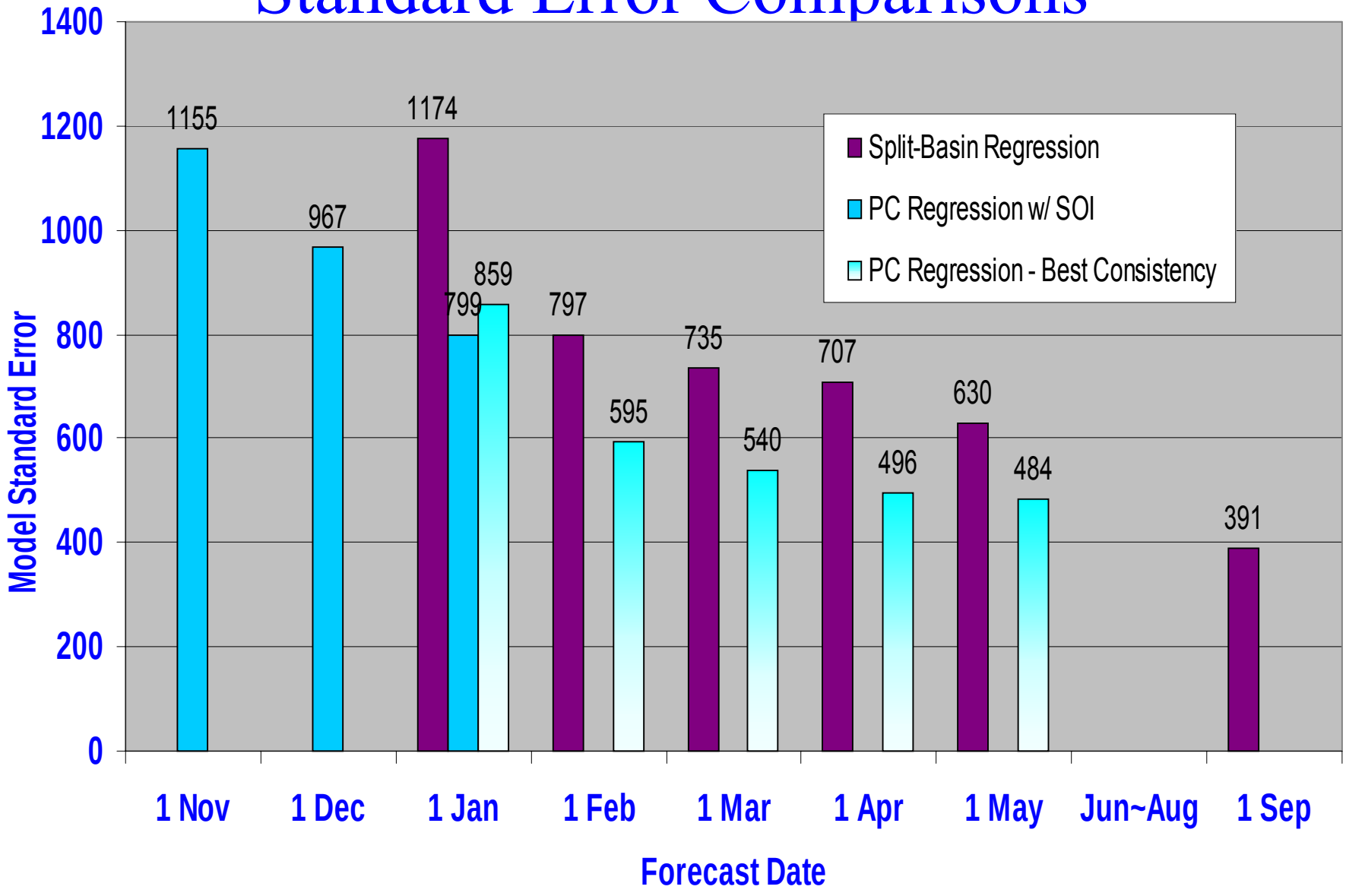
Current Libby Forecast Model Standard Errors



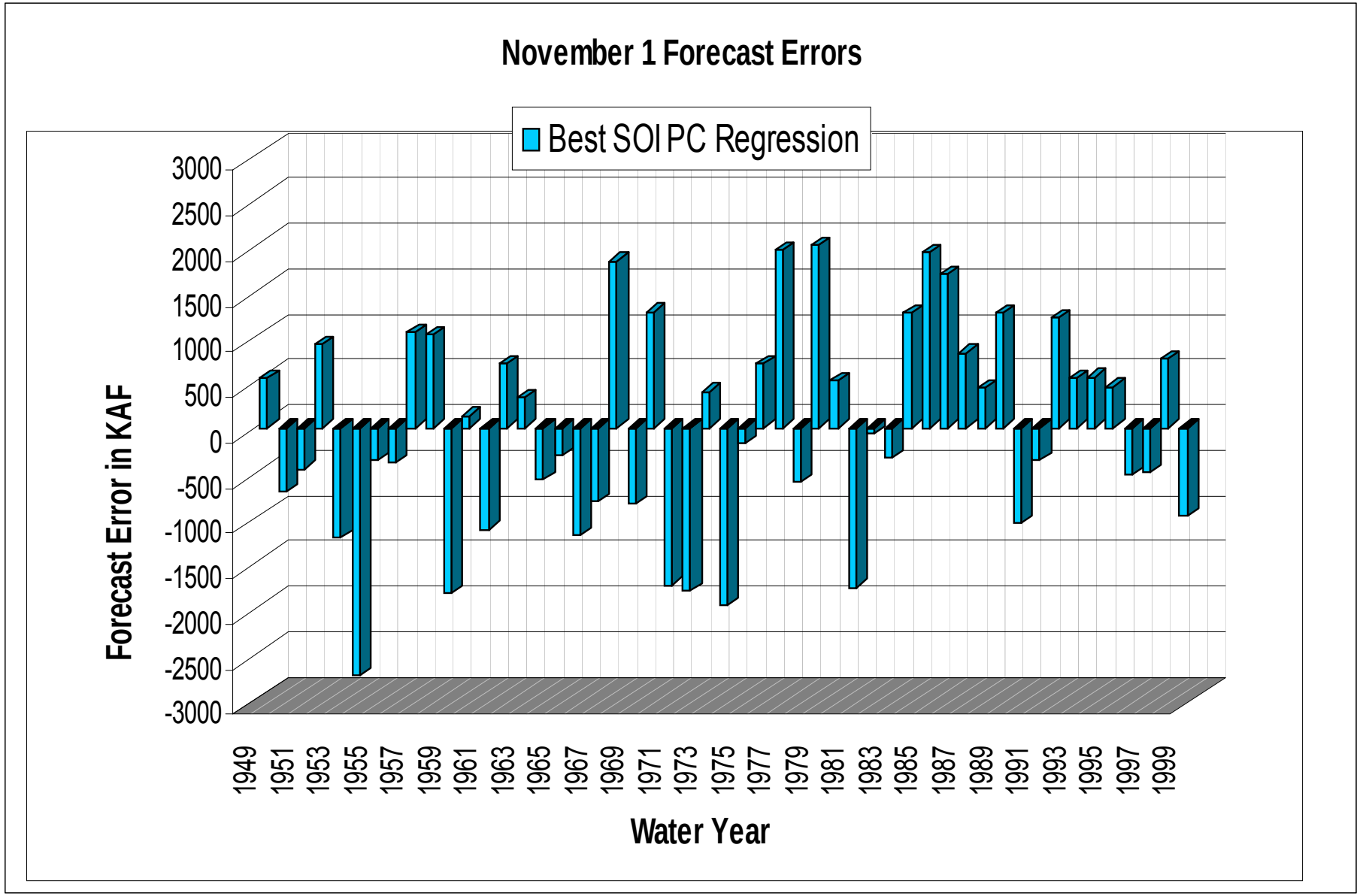
Libby Fall Forecast Model

- Climate variable
  - Selected composite Σ June, July, Aug, Sept SOI
- Precipitation variables
  - 19 stations (9 MT, 2 ID, 7 BC, 1 AB)
- Snow variable
  - No reliable snow data prior to 1 January
- Principal components regression
  - 1 November, 1 December, 1 January forecasts

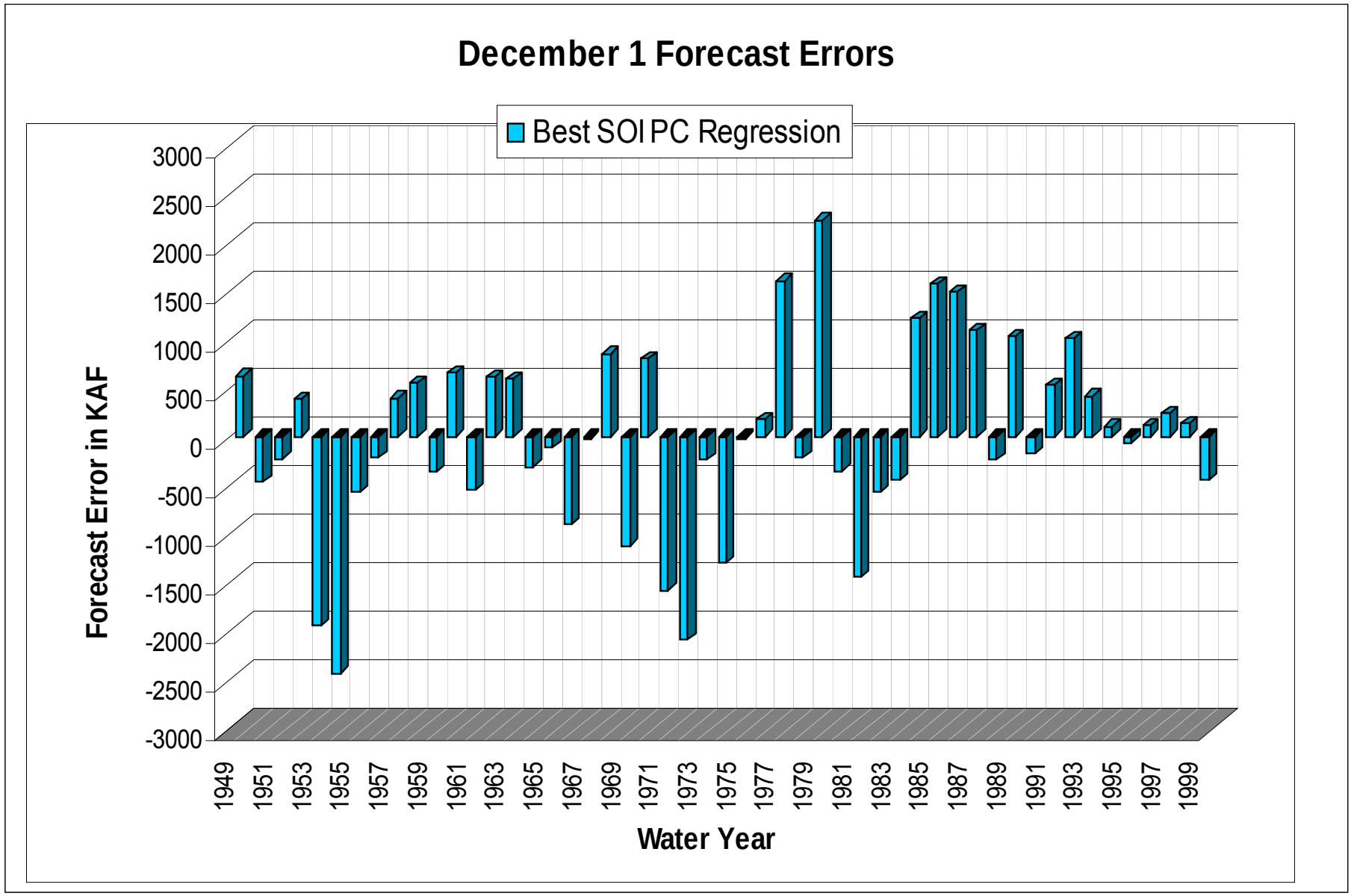
Libby Forecast Model
Standard Error Comparisons



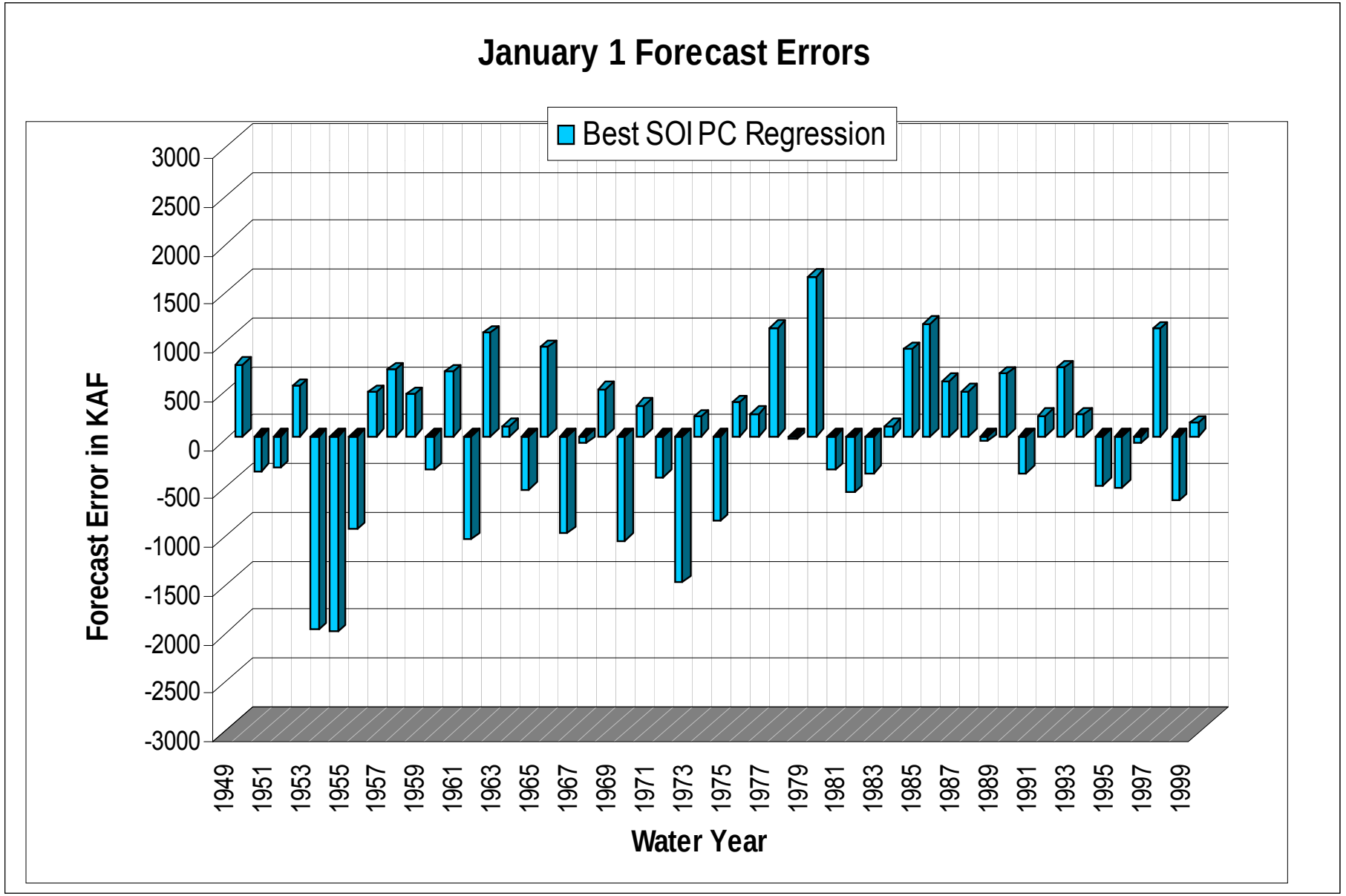
New Fall Libby Forecast Model – Nov Errors



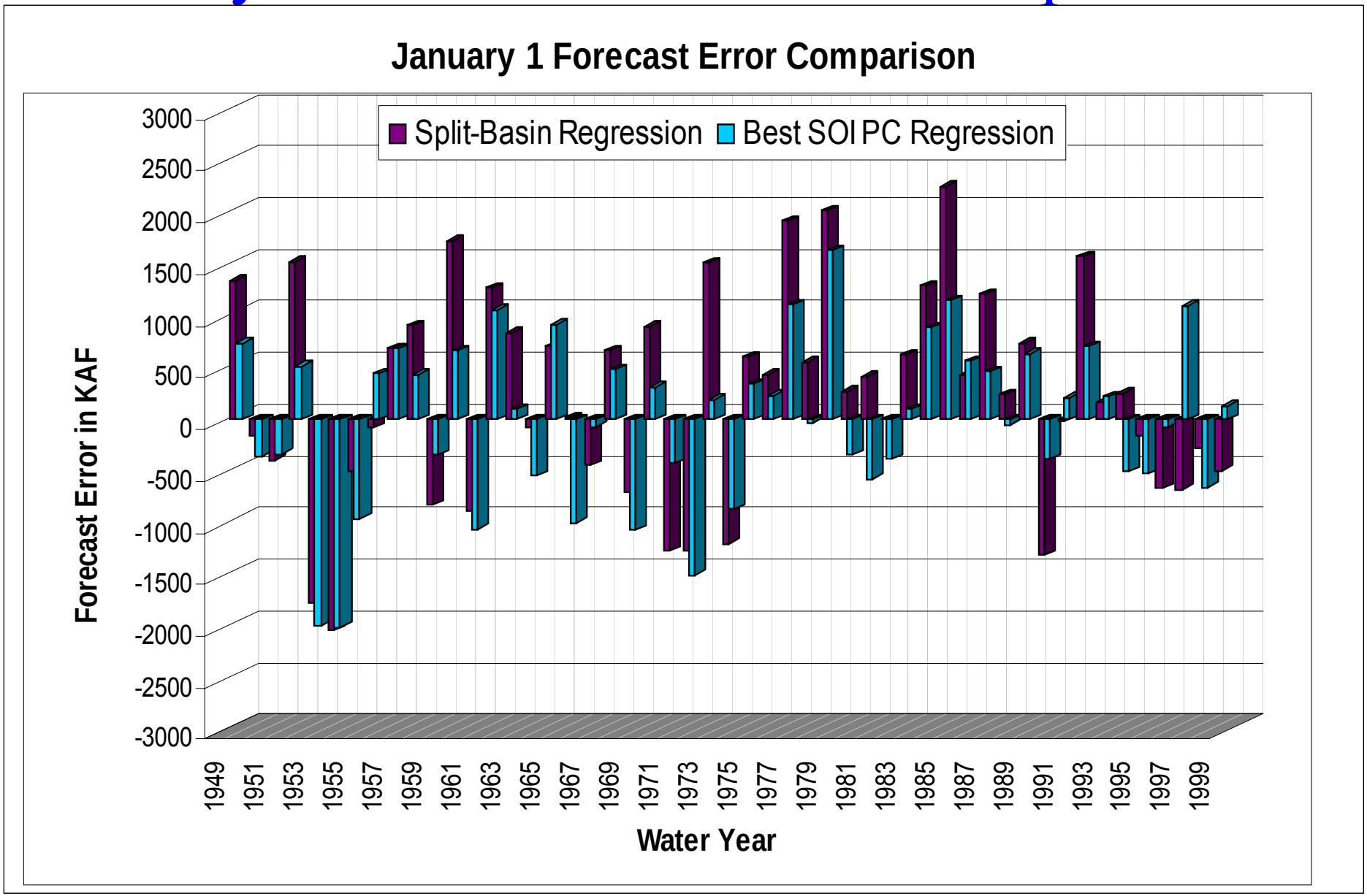
New Fall Libby Forecast Model – Dec Errors



New Fall Libby Forecast Model – Jan Errors



Libby Forecast Model Error Comparison



Current Investigations

Climate Variables

- SOI - Southern Oscillation Index
- ENSO – El Nino Southern Oscillation
- PDOI – Pacific Decadal Oscillation Index
- NPI – North Pacific Index

Fall vs Winter Models – Separate or Merged?

- Climate driven Fall model (no snow)
- Snow/rain driven Winter model

Questions?

Fall Forecasting Model

Fall Forecasting Model

– Lack of Snow Stations

- Snow Stations for 1 Nov and 1 Dec
  - No reliable snow stations
  - Filling in Morrissey Ridge and Moyie Mountain *might* be useful

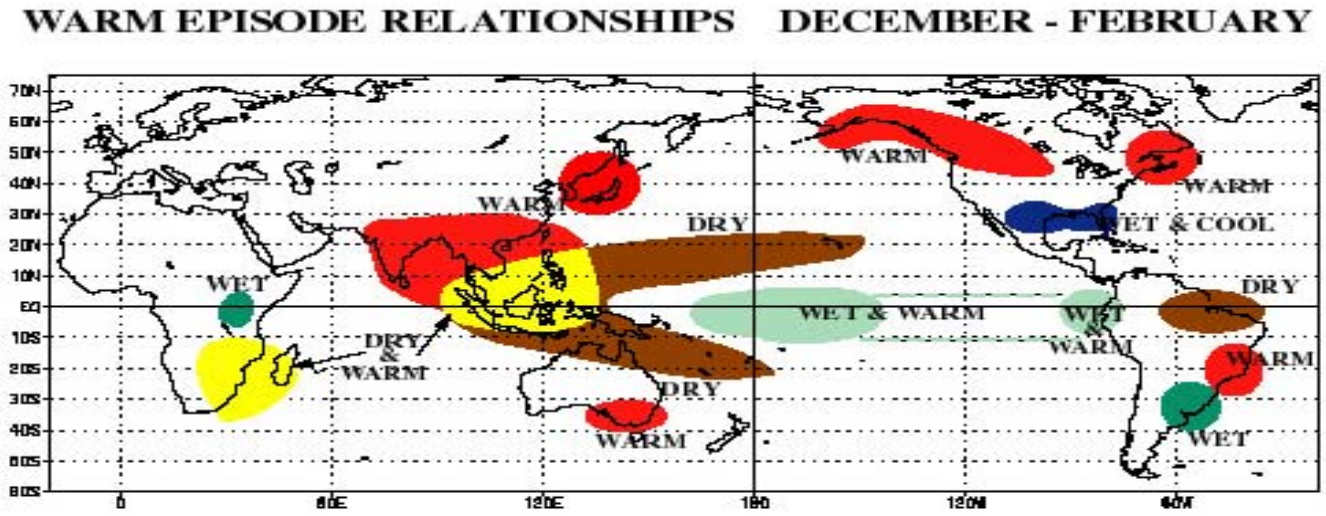
Station Name	State/ Province	Obs Date	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
East Creek	BC	1-Nov												X	X	X	E	E	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Floe Lake	BC	1-Nov																								E			X	X	X	X	X	X
Morrissey Ridge-P	BC	1-Nov											X	X	E	X																		X
Morrissey Ridge-Q	BC	1-Nov															X	X	X	X	X	X	X	E	X	X	X	X	X	X	X	E	E	
Moyie Mountain	BC	1-Nov			X	E	X	E	X	X	X	X	X	X	X	X	E	X	X	X	E	X									X	X	X	R
East Creek	BC	1-Dec												X	X	X	E	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Floe Lake	BC	1-Dec																								X			X	X	X	X	X	X
Morrissey Ridge-P	BC	1-Dec											X	X	X	X																		X
Morrissey Ridge-Q	BC	1-Dec															E	X	X	X	X	X	X	X	X	X	X	X	X	X	X	E	X	
Moyie Mountain	BC	1-Dec			X	X	X	X	E	X	X	X	X	X	X	X	E	E	X	X	X	X									X	X	X	X

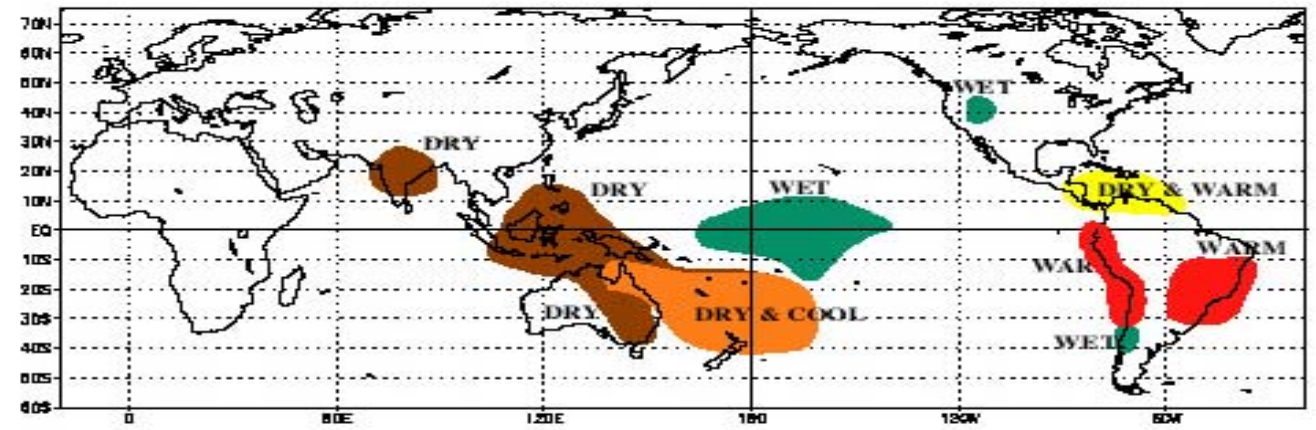
Fall Forecast Model

Forecast Date	R^2	# Variables	# Princ. Comp.s	# Years
1 Nov	.335	3	1	51
1 Dec	.534	5	1	51
1 Jan	.682	7	1	51

- 1 Nov = 75.0 ΣSOI_{JJAS} + 277.6 $WGLM_{Oct}$ + 141.3 $GRPB_{Oct}$ + 5202.7
- 1 Dec = 73.0 ΣSOI_{JJAS} + 230.6 $WGLM_{Oct}$ + 121.7 $GRPB_{Oct}$ + 394.0 $FTIM_{Nov}$ + 433.1 $BABB_{Nov}$ + 4327.4
- 1 Jan = 86.6 ΣSOI_{JJAS} + 103.4 $FREB_{Oct}$ + 100.3 $GRPB_{Oct}$ + 447.5 $FTIM_{Nov}$ + 431.1 $BABB_{Nov}$ + 223.1 $POLM_{Dec}$ + 169.5 $BFEI_{Dec}$ + 3332.9

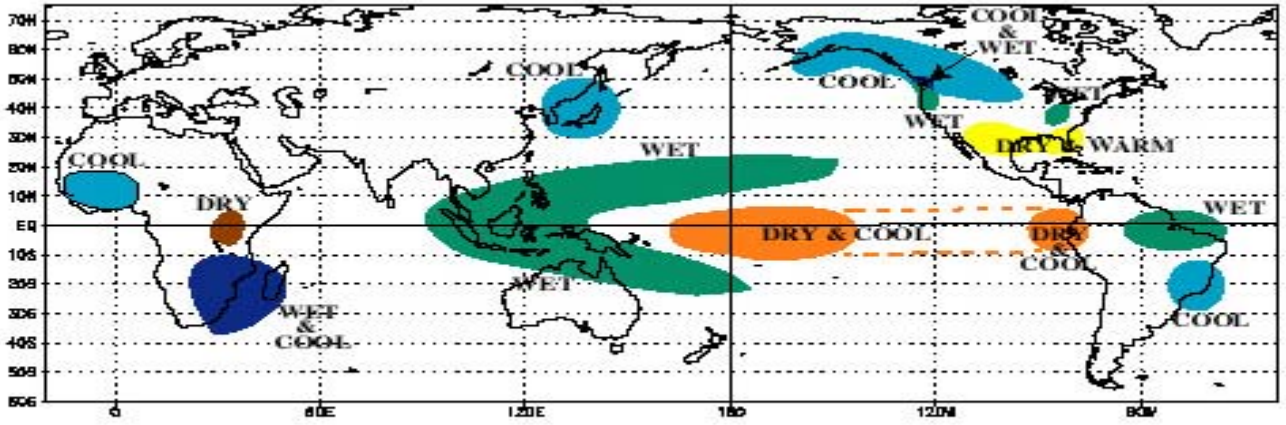
Climate Variable – ENSO Warm



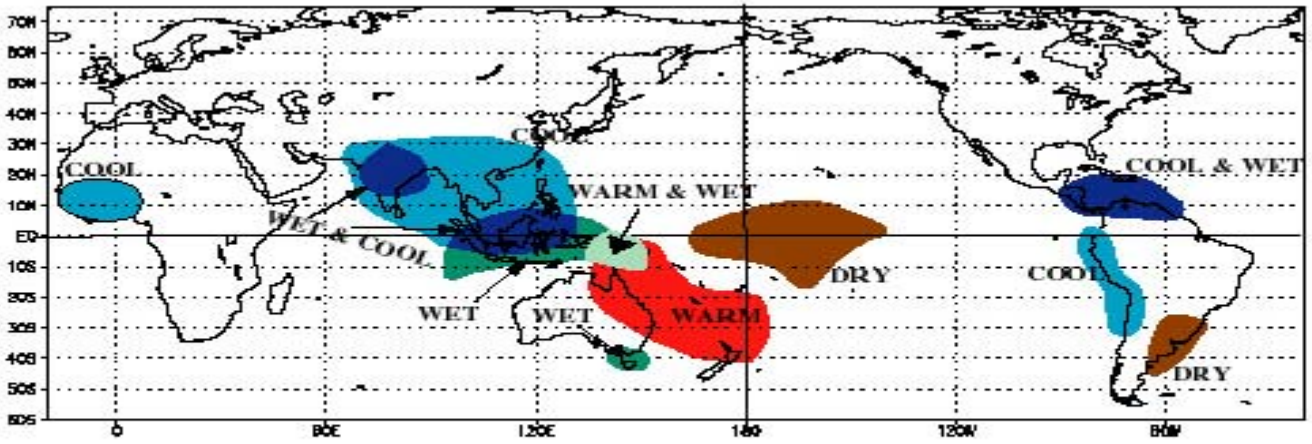


Climate Variable – ENSO Cold

COLD EPISODE RELATIONSHIPS DECEMBER - FEBRUARY

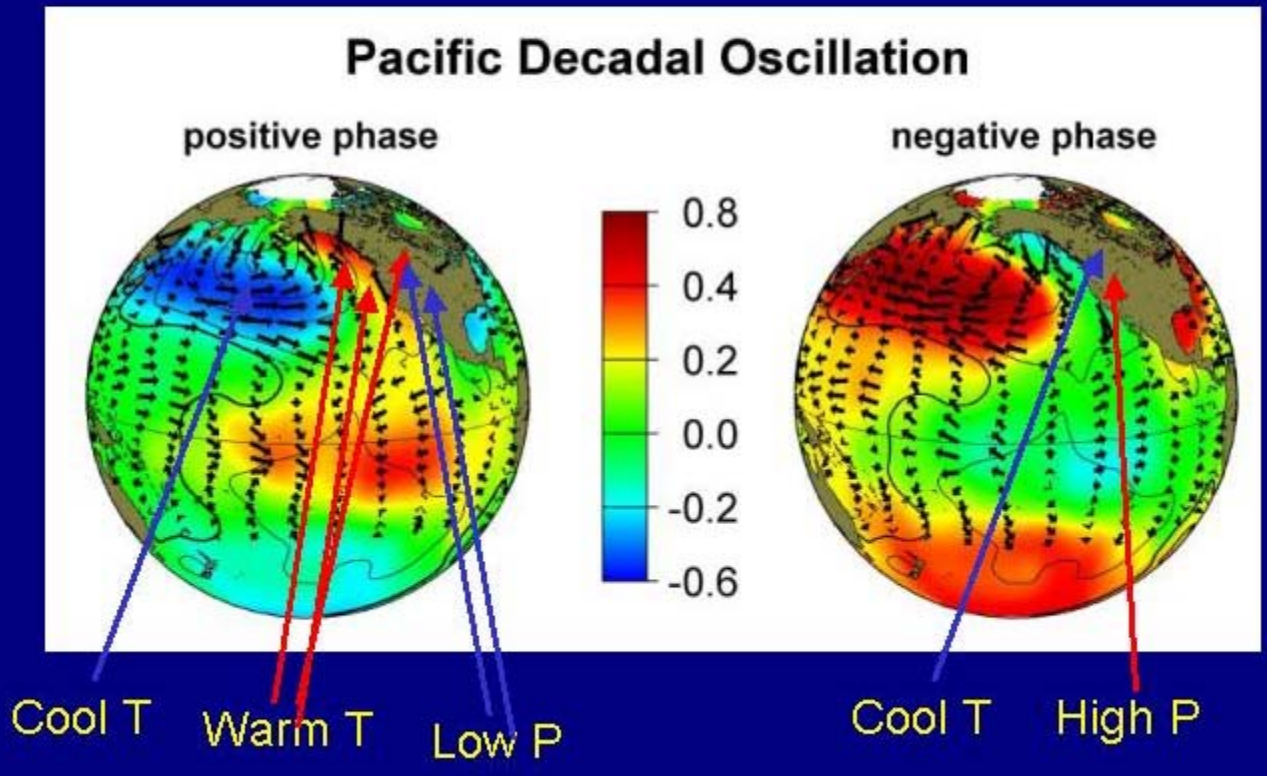


COLD EPISODE RELATIONSHIPS JUNE - AUGUST

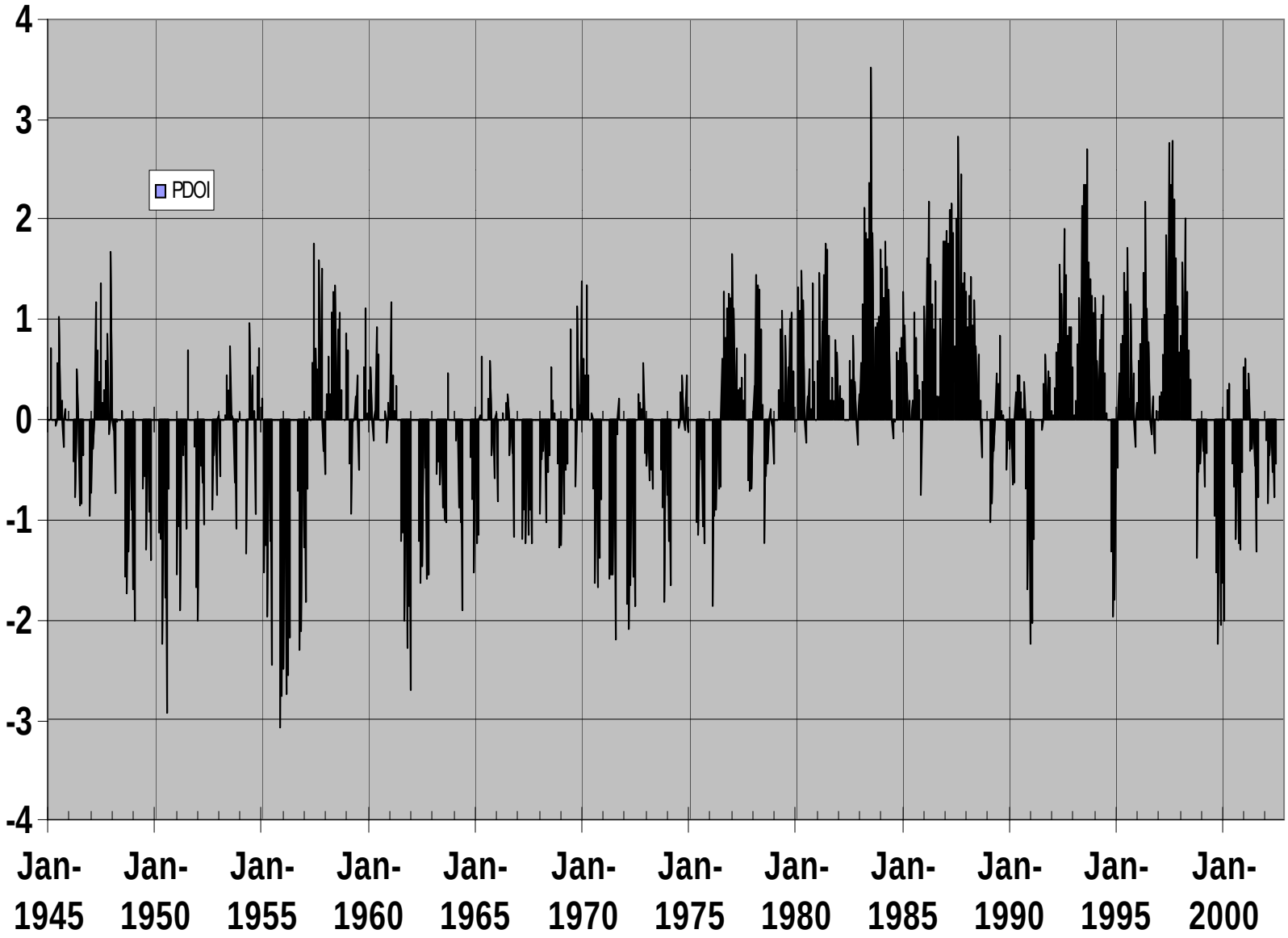


Climate Variable - PDO

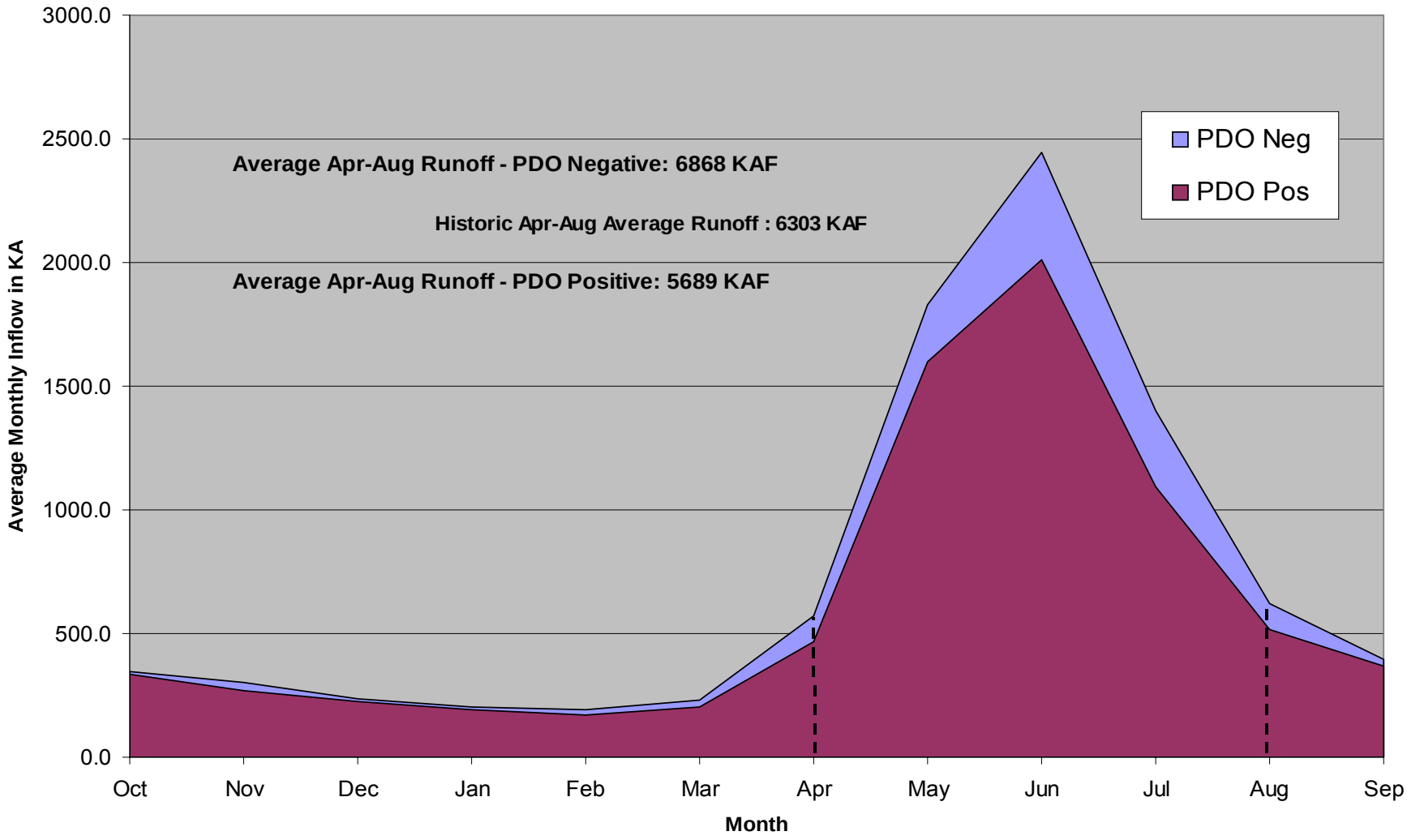
The effect of warm (positive) and cool (negative) phases of the PDO on western N American climate



Monthly PDO Index 1945 - 2002

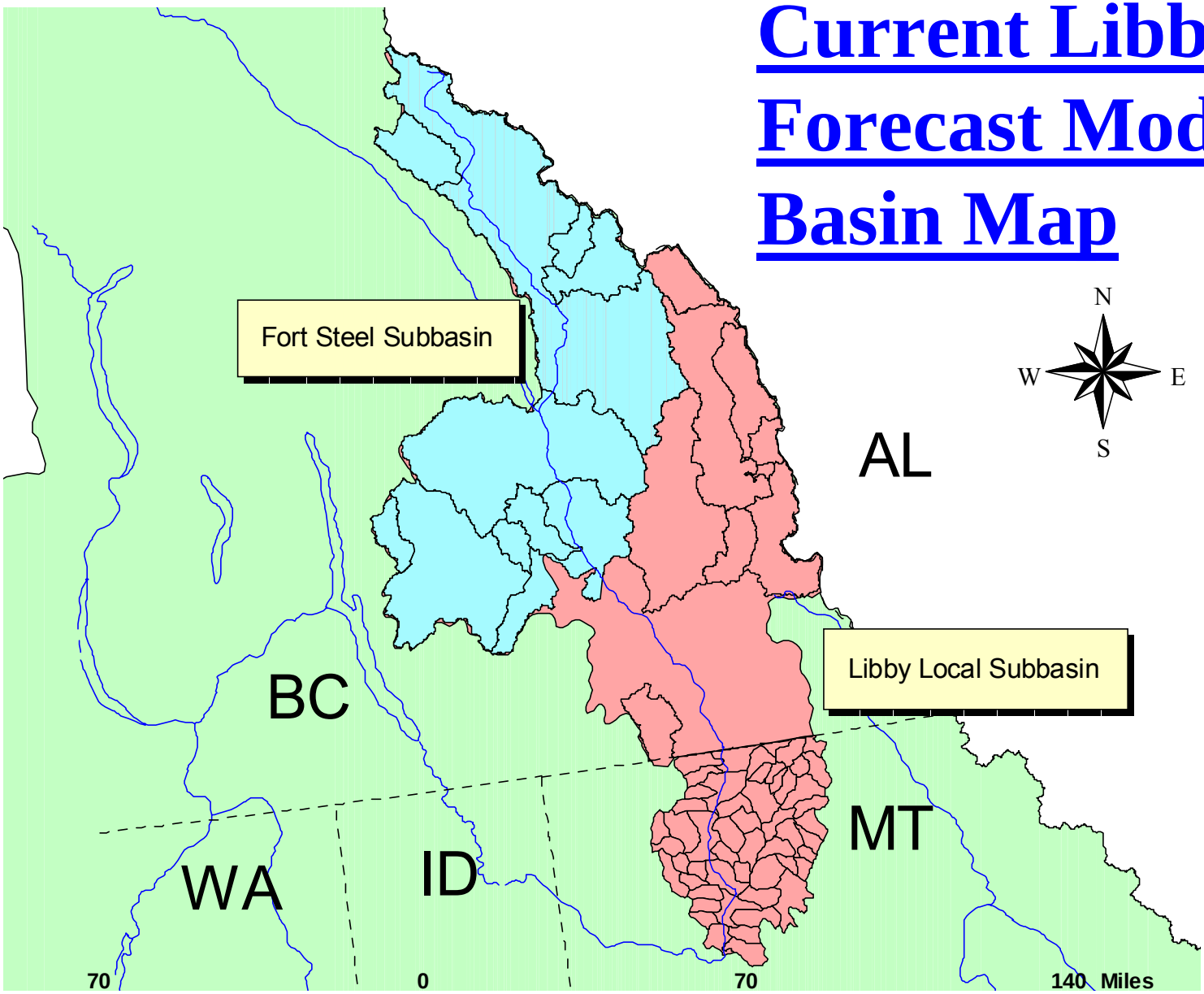


Libby Runoff vs Oct-Dec PDO Climate Index



Current Libby Forecast Model

Current Libby Forecast Model – Basin Map



Current Libby Forecast Model

Variable	Ft Steel Basin	Libby Local Basin
1 April Snow Water Equivalent (SWE)	Σ MILB, MORB, KGHB, SUMB, MBCB, GRPB, NFRB	Σ SUMB, NFRB, RMTM, KIMB, WSLM, 0.5*MORB
Winter (Oct--Mar) Precipitation (WP)	Σ Oct, Nov, Dec, Jan, Feb, Mar Σ ELKB, BABB, GRPB, BRIB, KASB	Σ Oct, Nov, Dec, Jan, Feb, Mar Σ ELKB, FENB, FTIM, LRSM, BONI, POLM
Spring (Apr--Aug) Precipitation (SP)	Σ Apr, May, .8 Jun, .5 Jul, .2 Aug Σ BRIB, KASB, PTHI, WASB, CRSB	Σ Apr, May, .8 Jun, .5 Jul, .2 Aug Σ FTIM, PTHI, KASB, WHFM
Fall Runoff (FRO)	Σ Oct, Nov Ft Steele basin runoff	Σ Oct, Nov Libby Local basin runoff

Current Libby Forecast Model - Flows