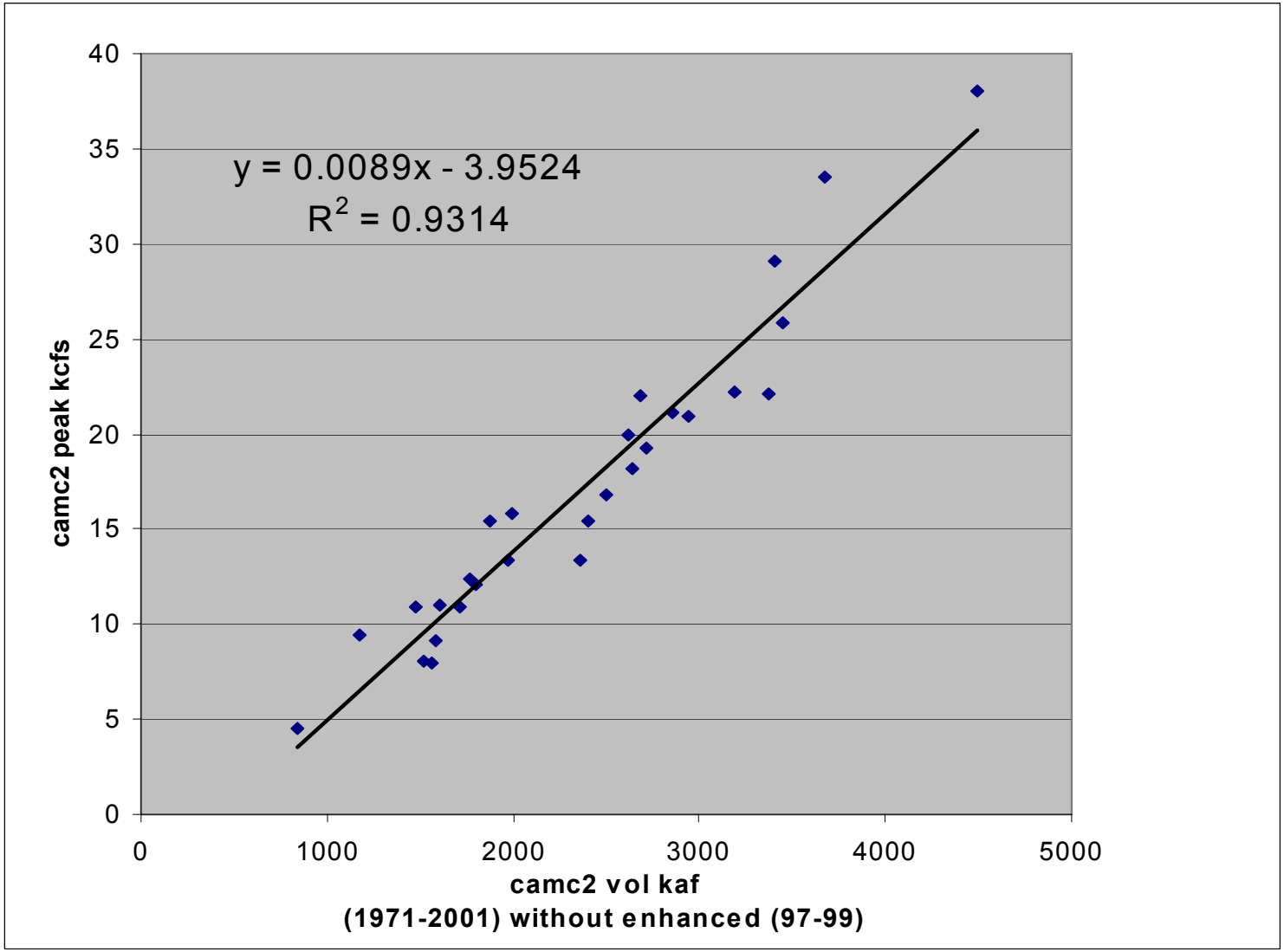
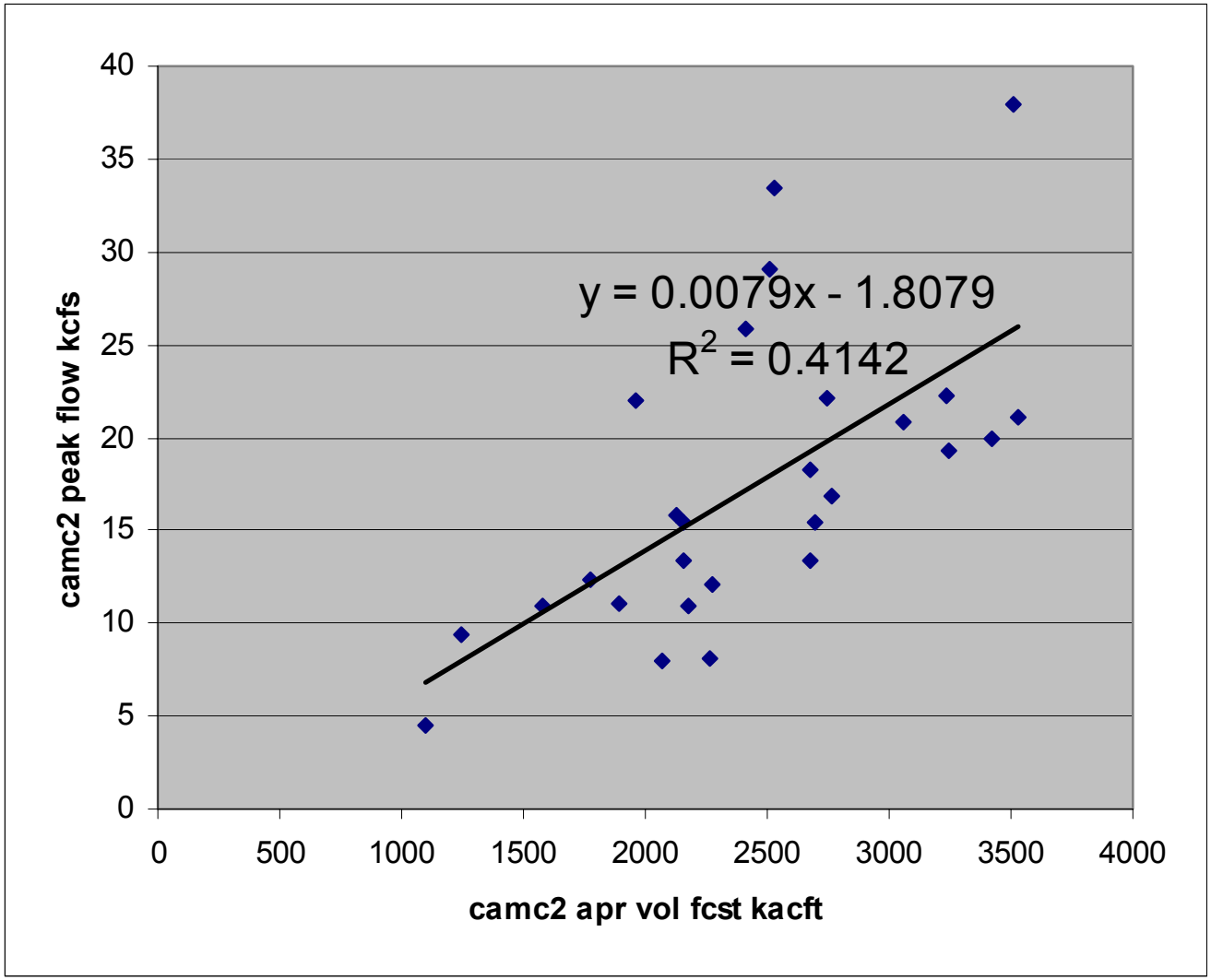
Linear Regression of Observed April-July Natural Volume at Colorado near Cameo versus Observed Peak Flow



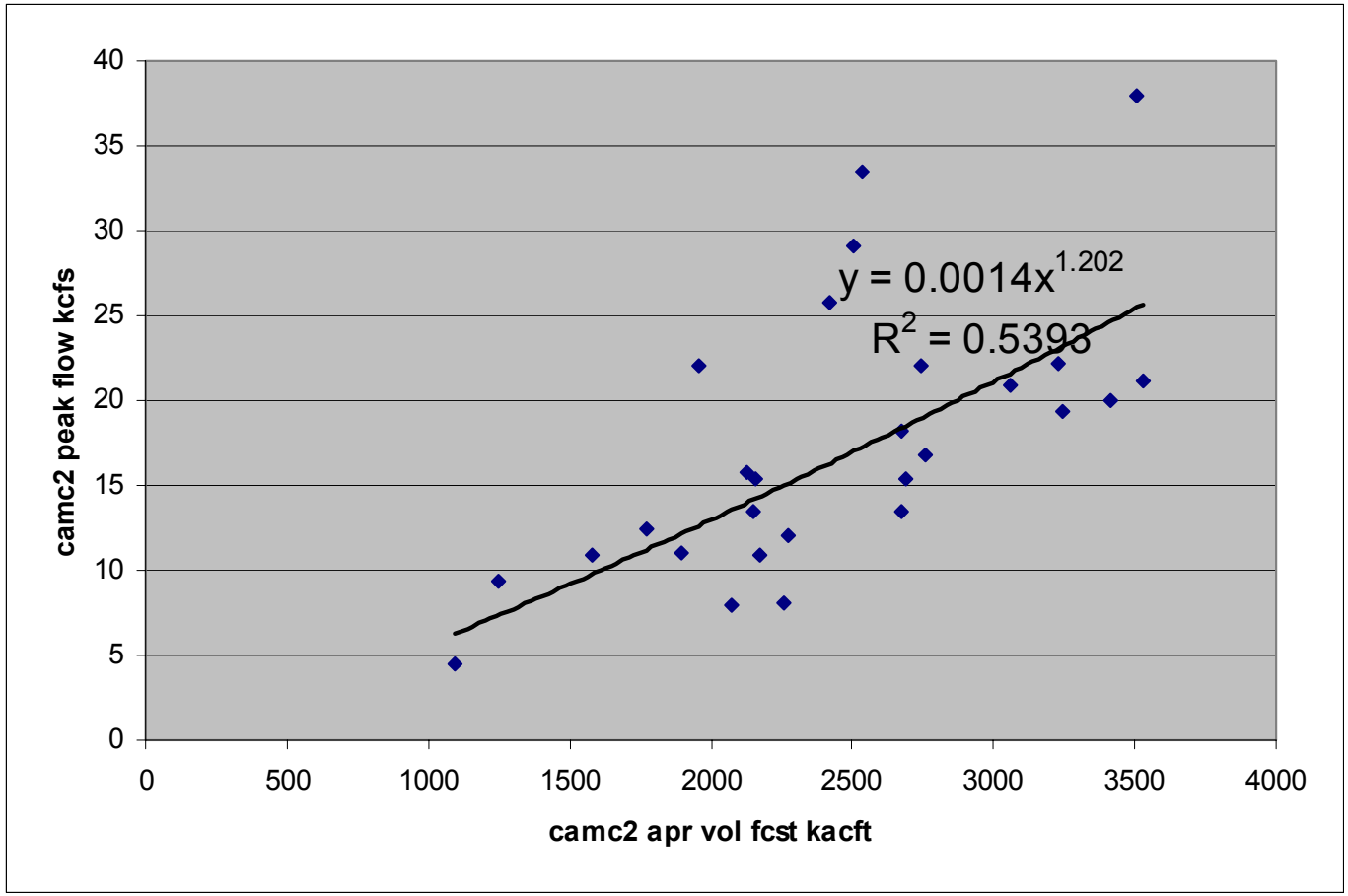
Forecast Volume of 1930 kaf would give peak of 13222 cfs

Linear Regression of Forecast April-July Natural Volume at Colorado near Cameo versus Observed Peak Flow



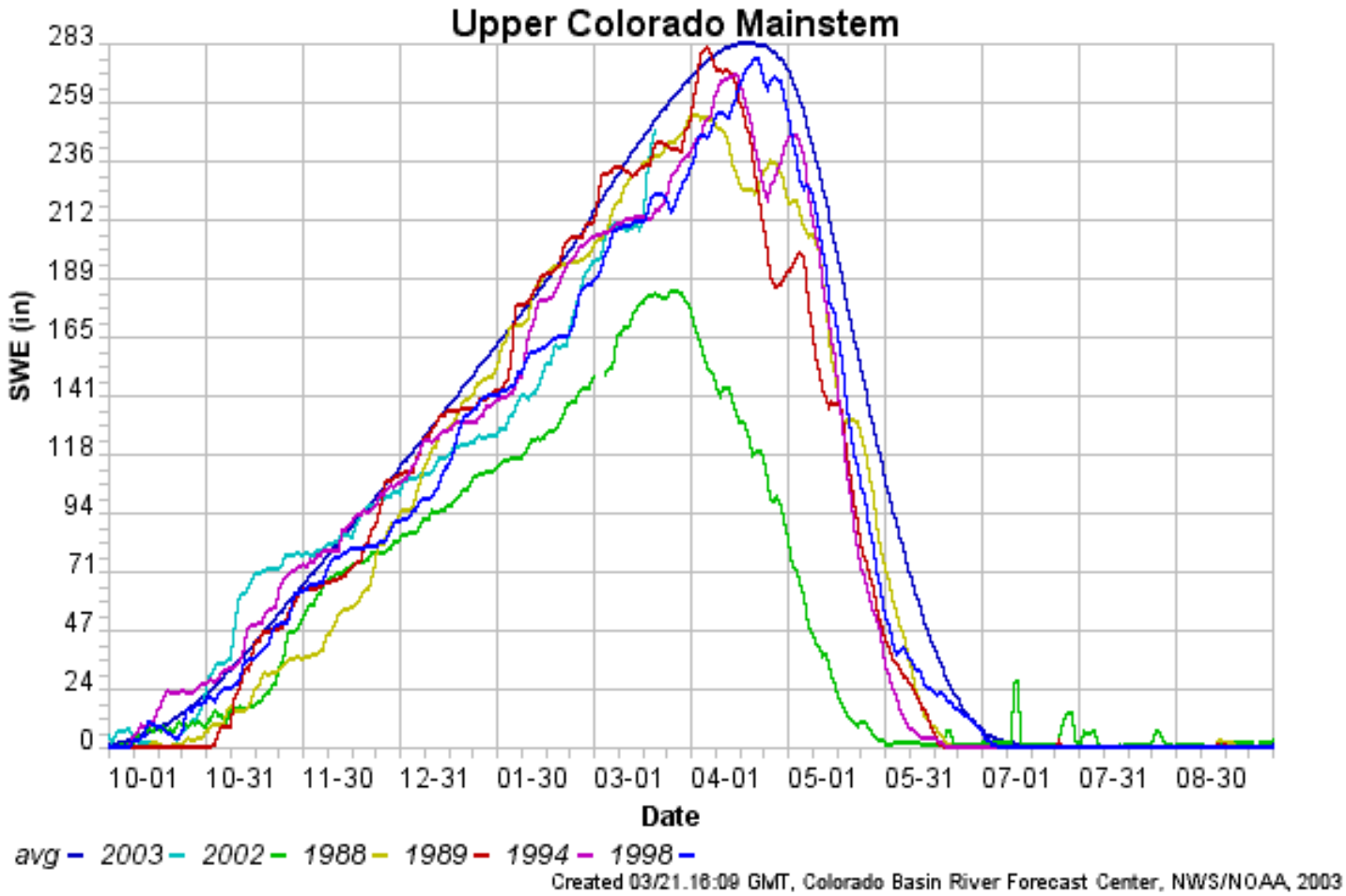
Forecast Volume of 1930 kaf would give peak of 13440 cfs

Power Equation of Forecast April-July Natural Volume at Colorado near Cameo versus Observed Peak Flow



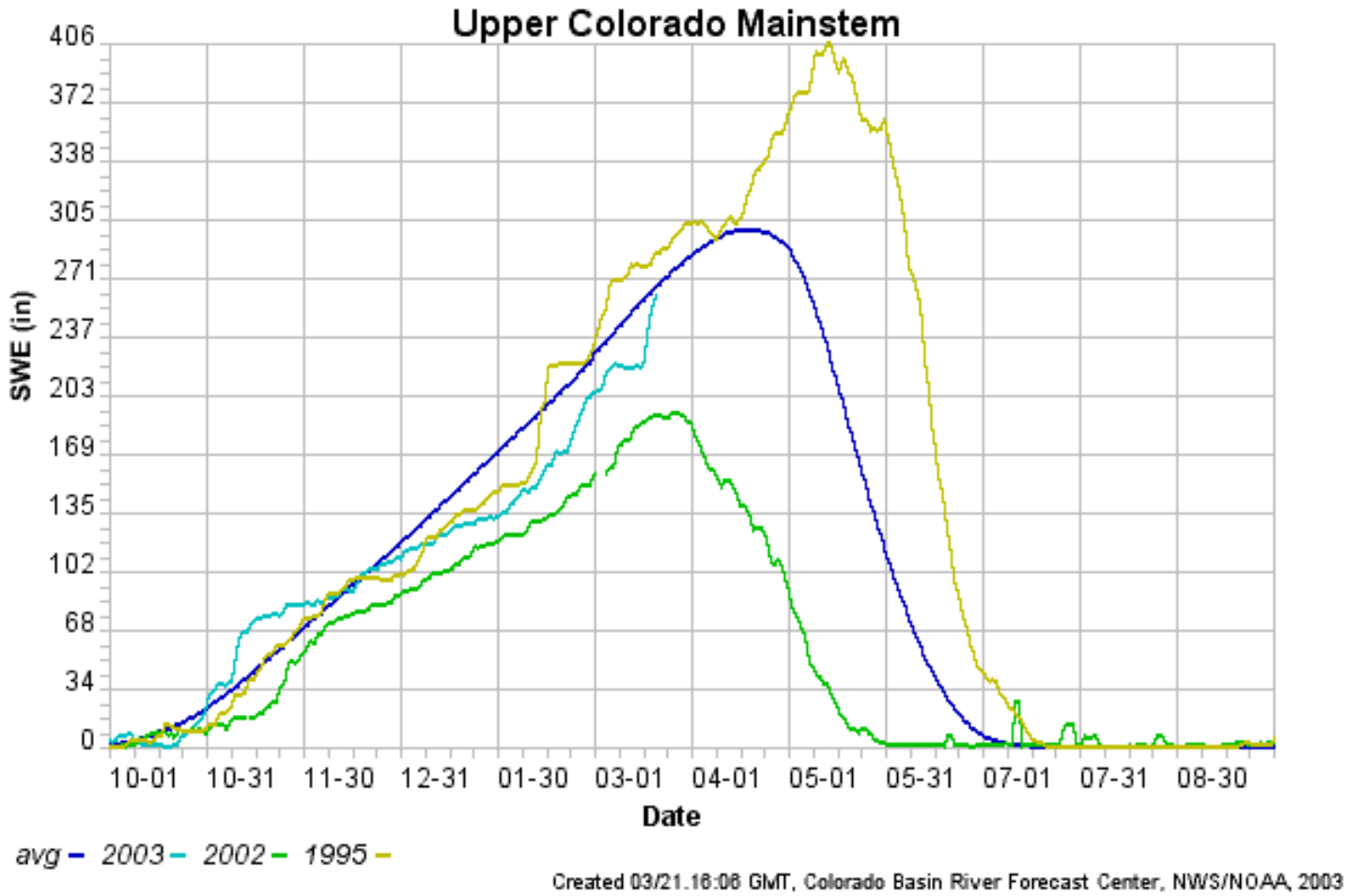
Forecast Volume of 1930 kaf would give peak of 12460 cfs

Past Years with Similar Snowpacks on March 21st



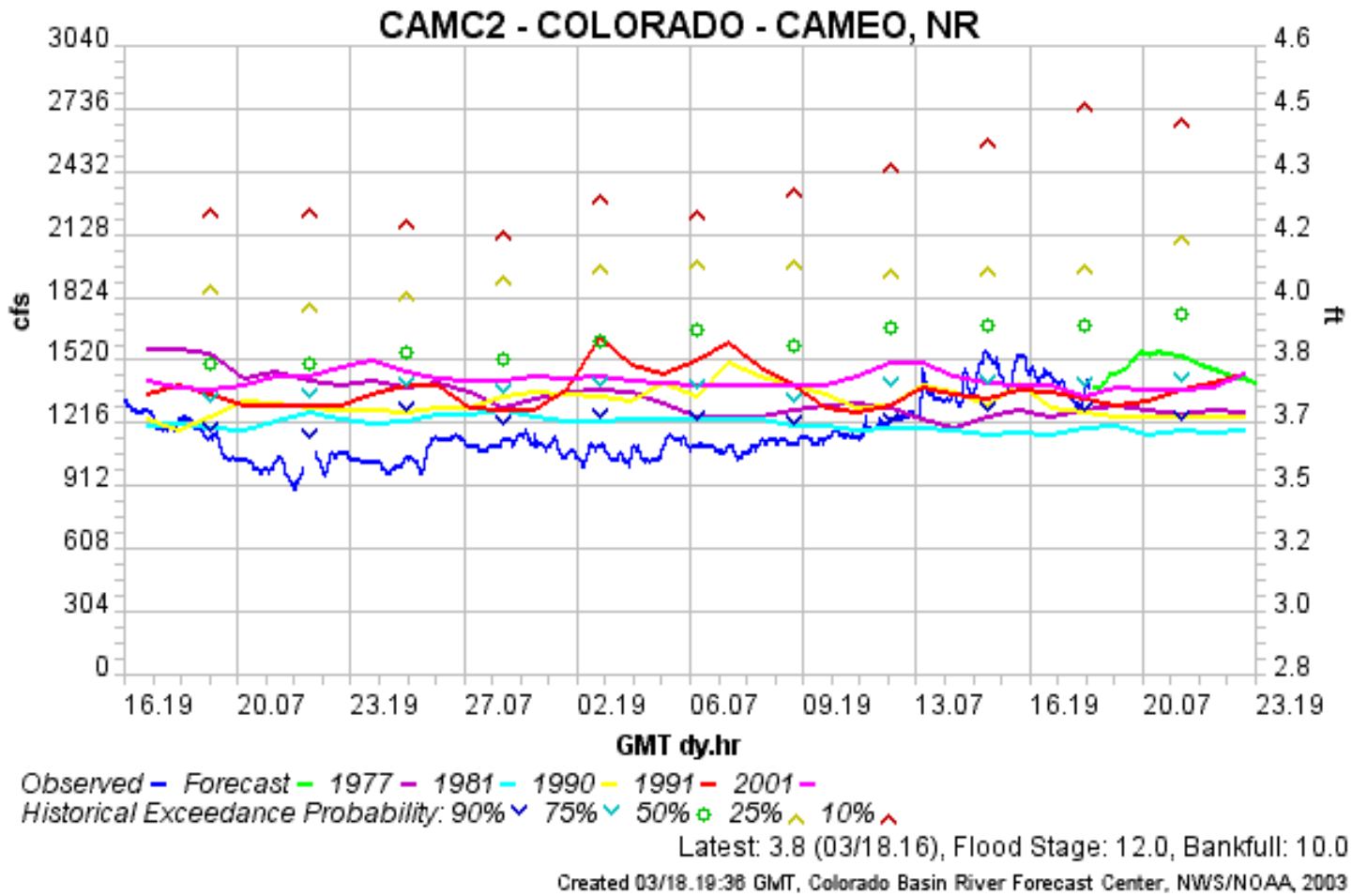
Year	2003	2002	1988	1989	1994	1998*
Vol	1930(f)	695	1801	1516	1610	2253
Peak	13000(f)	4020	12100	8050	11000	15100*

Past Years with Similar Snowpacks on March 21st

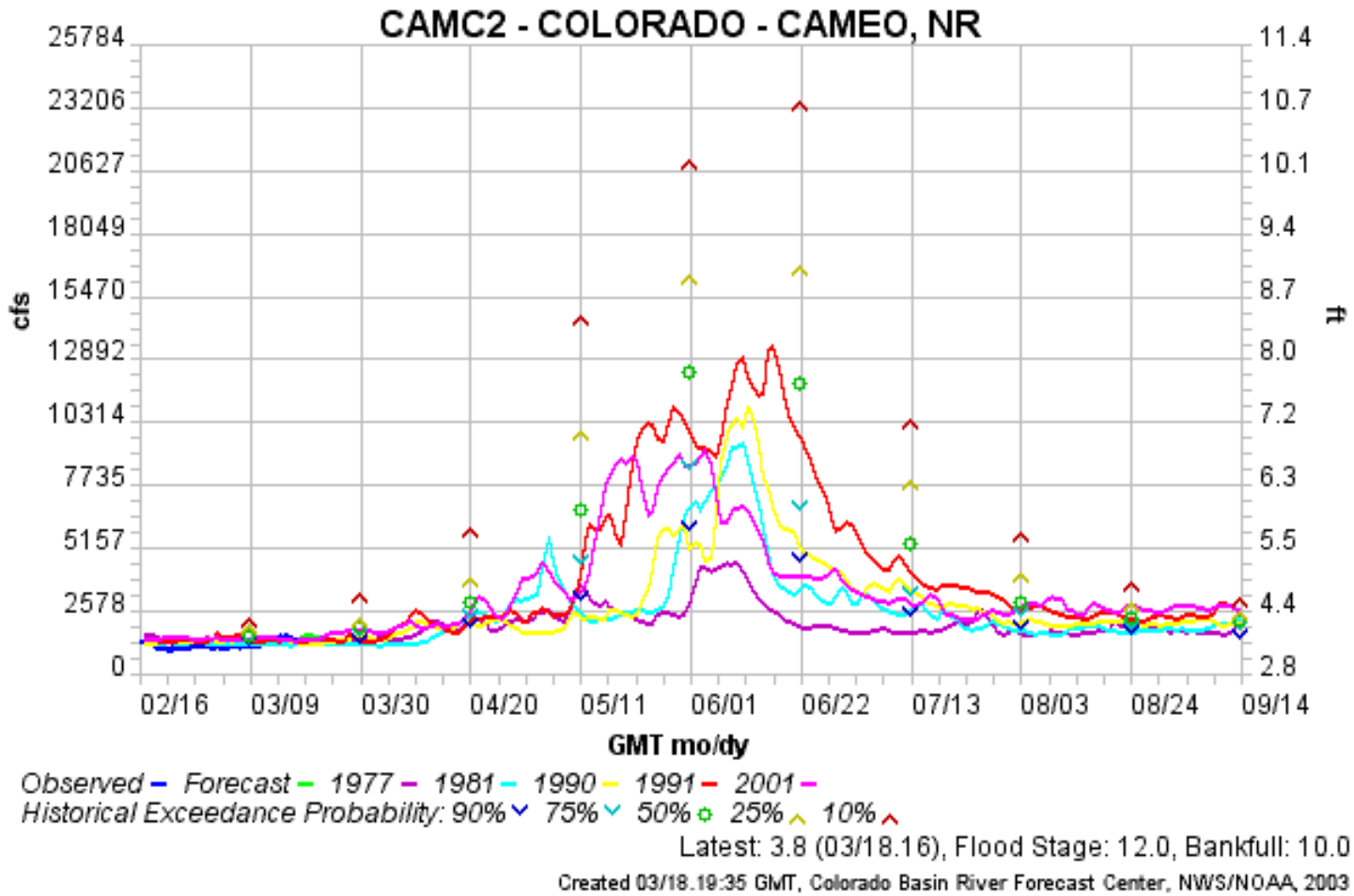


Year	1995	Similar El Nino signals as well, WWNNC-
Vol	3406	
Peak	29100	

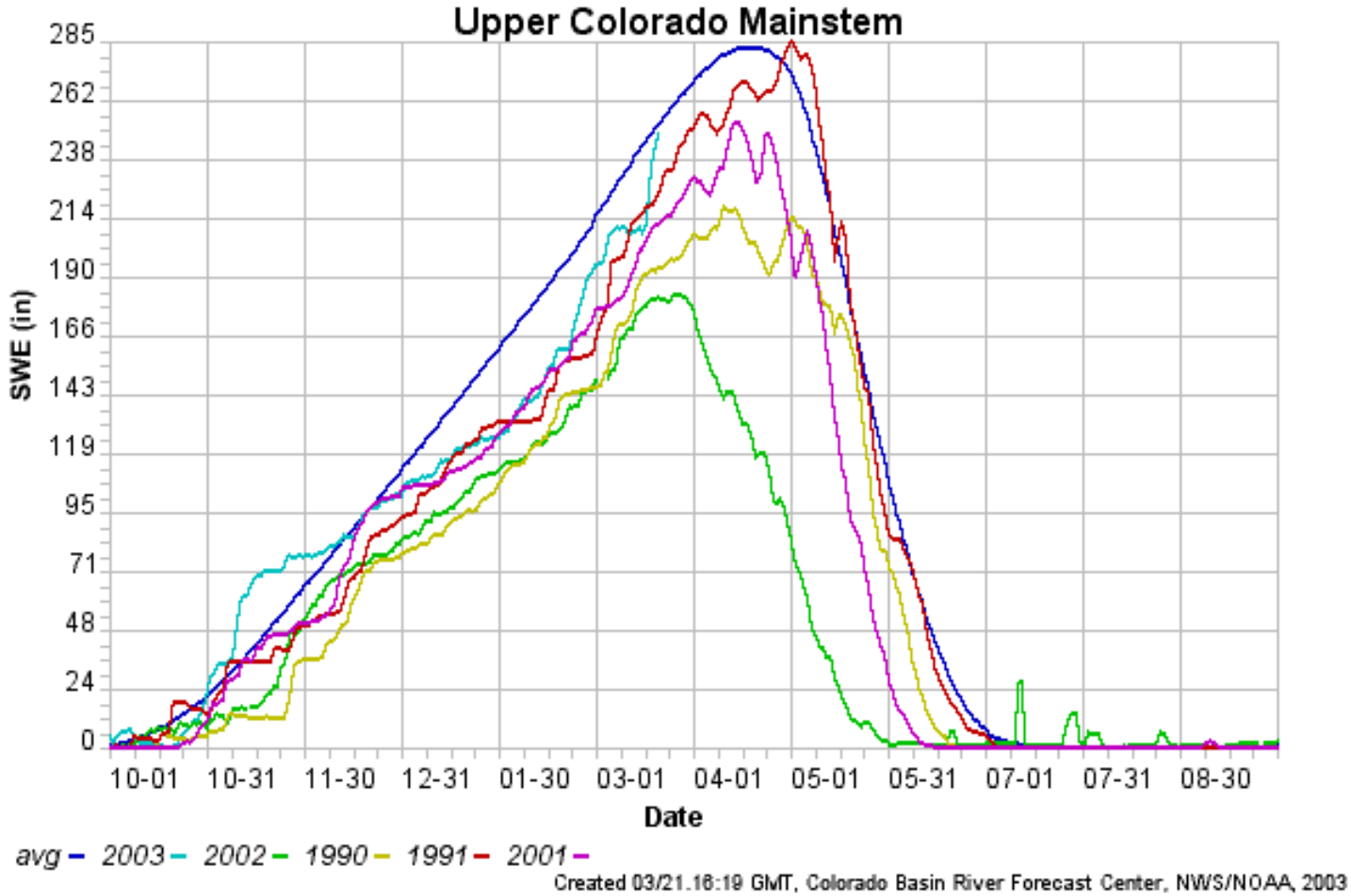
Past Years with Similar Flows on March 18th



Past Years with Similar Flows on March 18th

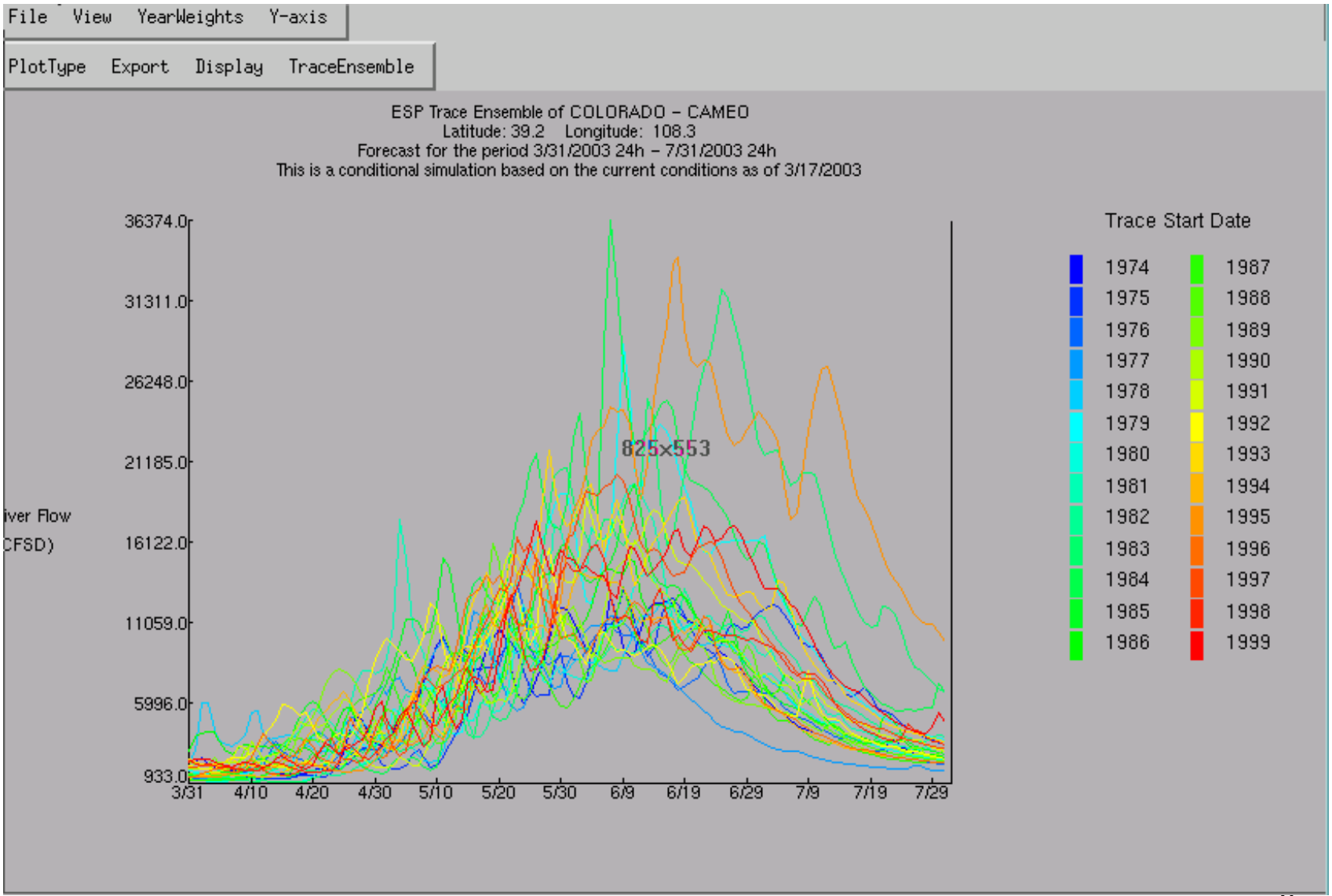


The Snow from Past Years with Similar Flows on March 21st



Year	2003	2002	1990	1991	2001
Vol	1930(f)	695	1478	1972	1586
Peak	13000(f)	4020	10900	13400	9180

ESP Traces


File View YearWeights Y-axis
PlotType Export Display TraceEnsemble
ESP Trace Ensemble of COLORADO – CAMEO
Latitude: 39.2 Longitude: 108.3
Forecast for the period 3/31/2003 24h – 7/31/2003 24h
This is a conditional simulation based on the current conditions as of 3/17/2003
36374.0
31311.0
26248.0
21185.0
16122.0
11059.0
5996.0
933.0
iver Flow
CFSD)
825x553
3/31 4/10 4/20 4/30 5/10 5/20 5/30 6/9 6/19 6/29 7/9 7/19 7/29
Trace Start Date
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

ESP

Log Normal

```
# Analysis Period: 3/17/2003 24 - 9/29/2003 24 MST
# Interval: 3/31/2003 - 7/31/2003 MST
#
# Statistics based on all years.
#
# EXCEEDANCE PROBABILITY ESTIMATES
#
# Distribution: LogNormal
#      CS: Mean: 9.74, StdDev: 0.37
#      HS: Mean: 10.03, StdDev: 0.44
#     ER1: Mean: -999.00, StdDev: -999.00
#     ER2D: Mean: -999.00, StdDev: -999.00
#     ER2S: Mean: -999.00, StdDev: -999.00
#     ER3D: Mean: -999.00, StdDev: -999.00
#     ER3S: Mean: -999.00, StdDev: -999.00
#     OBS: Mean: 10.07, StdDev: 0.39
#    BIAS: Mean: -999.00, StdDev: -999.00
# Exceedance     Conditional    Historical     Historical
# Probabilities  Simulation     Simulation     Observed
# ----------------------------------------------------------
  0.900          10513.708      12875.006      14300.800
  0.750          13180.782      16865.395      18102.564
  0.500          16939.395      22756.652      23515.352
  0.250          21769.805      30705.787      30546.594
  0.100          27292.281      40222.523      38667.188
```

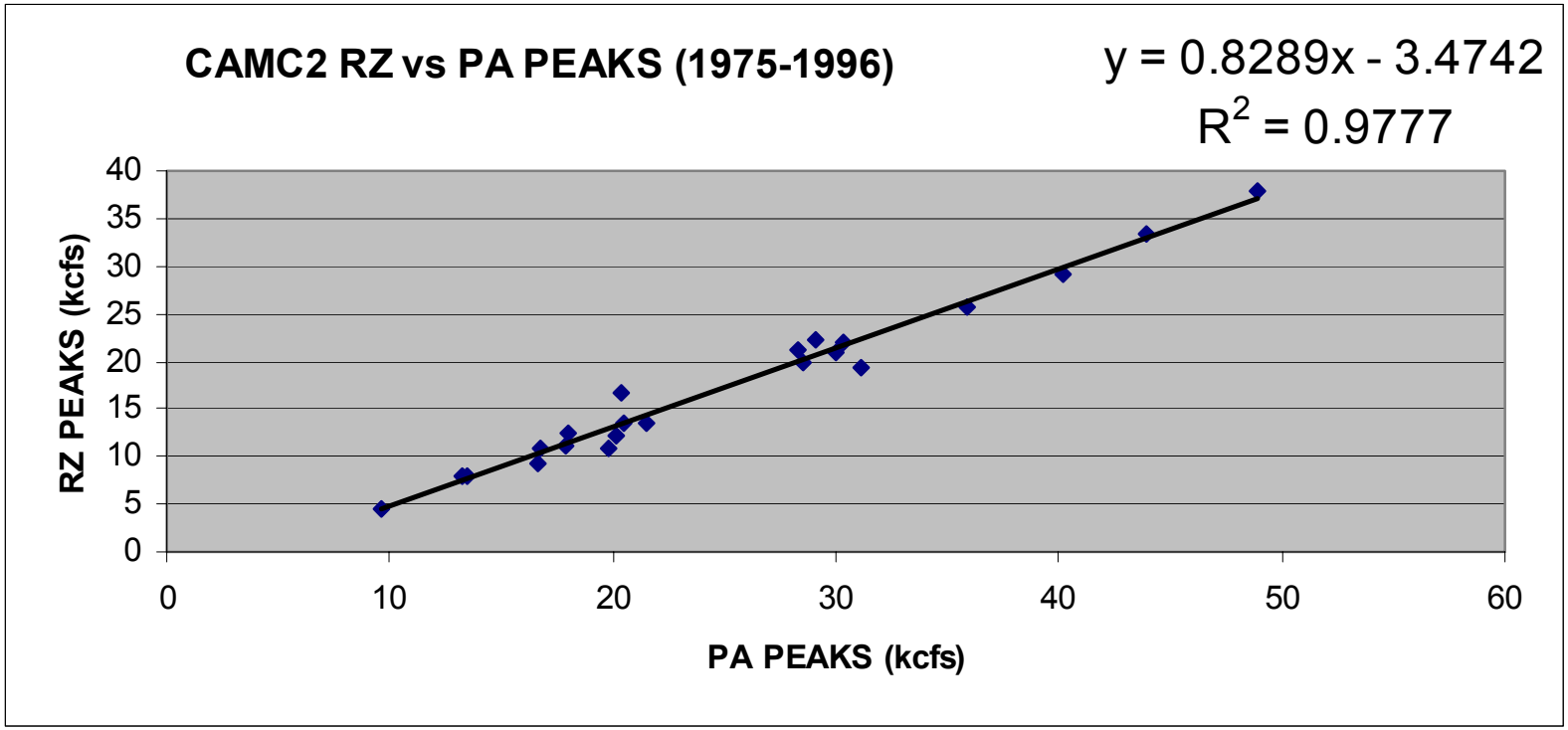
Empirical

```
# Analysis Period: 3/17/2003 24 - 9/29/2003 24 MST
# Interval: 3/31/2003 - 7/31/2003 MST
#
# Statistics based on all years.
#
# EXCEEDANCE PROBABILITY ESTIMATES
#
# Distribution: Empirical
#      CS: Mean: 18153.79, StdDev: 6996.22
#      HS: Mean: 25118.19, StdDev: 11736.32
#     ER1: Mean: -999.00, StdDev: -999.00
#     ER2D: Mean: -999.00, StdDev: -999.00
#     ER2S: Mean: -999.00, StdDev: -999.00
#     ER3D: Mean: -999.00, StdDev: -999.00
#     ER3S: Mean: -999.00, StdDev: -999.00
#     OBS: Mean: 25353.94, StdDev: 10220.05
#    BIAS: Mean: -999.00, StdDev: -999.00
# Exceedance     Conditional    Historical     Historical
# Probabilities  Simulation     Simulation     Observed
# ----------------------------------------------------------
  0.900          12186.835      14376.983      13330.094
  0.750          13191.306      15786.938      17872.221
  0.500          15780.010      21483.121      21003.541
  0.250          19876.930      35324.258      30923.506
  0.100          32586.141      39737.715      42008.832
```

Also have ability to weight years based on similarity to current snowpack or El Nino/La Nina or CPC guidance.

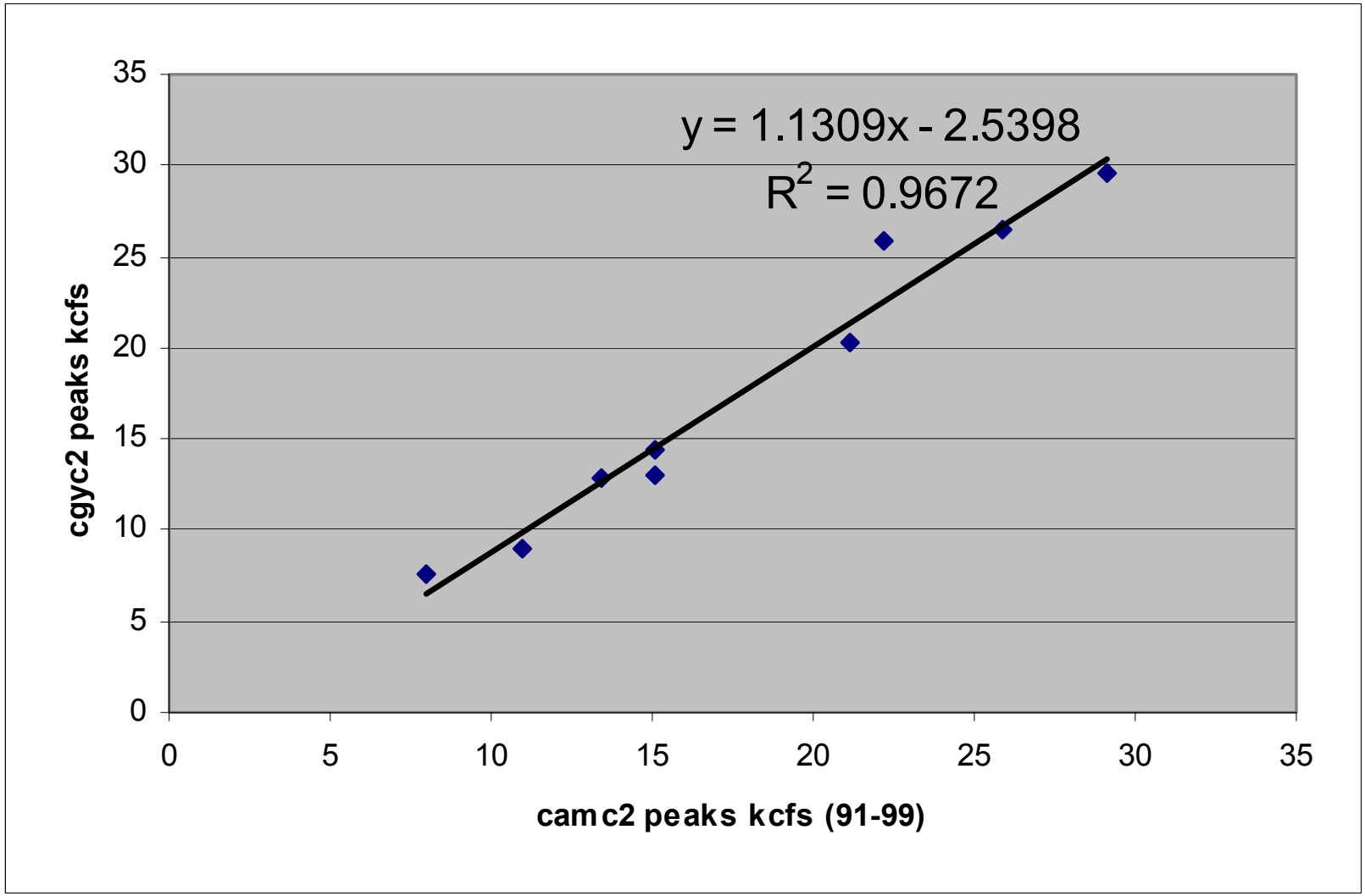
Here is where MRF temperature forecasts will come into play. May not cause huge difference in peak forecast out a couple of months due to variety of tools, but could be major player as we get within a few weeks of peak both as to magnitude and date of peak. Time will tell…

Linear Regression of Natural Peak Flow at Colorado near Cameo versus Observed Peak Flow



Log Normal Forecast Peak (18895) = 12190 cfs **Empirical Forecast Peak (16820) = 10470 cfs**

Linear Regression of Observed Peak Flow at Colorado near Cameo versus Observed Peak Flow at Colorado below Grand Valley Diversion near Palisade



When will peak occur?

Several tools…

1) NDMX (number of days to maximum) in ESP. MRF temperature forecasts may be big help here.

2) Use IFP (Interactive Forecast Program) out 1 to 2 weeks (some regulation included in shorter term).

3) Knowledge of "normal period of peak" to watch more closely.

4) Subjectively watch melt and flows and compare to past years (generally at least 50% of snow must have melted at index of 13 Snotel sites before we'll see peak).

Current Forecast for Cameo Peak Flow

STATION NAME	Historic Peak	Average Peak	Flood* Flow	2002 Peak	2002 Date	2003 Forecast Exceedance Probability 90%	75%	**50%**	25%	10%	Normal time of peak
COLORADO - CAMEO, NR	38,000	17,500	28,550	4,020	6/02	7,000	10,000	**13,000**	16,000	20,000	5/29 - 6/18