Forecasting Water Supply with B120 Statistical Methods Example:Cosumnes River

California Cooperative Meeting 11/8/12

By John j. King PE

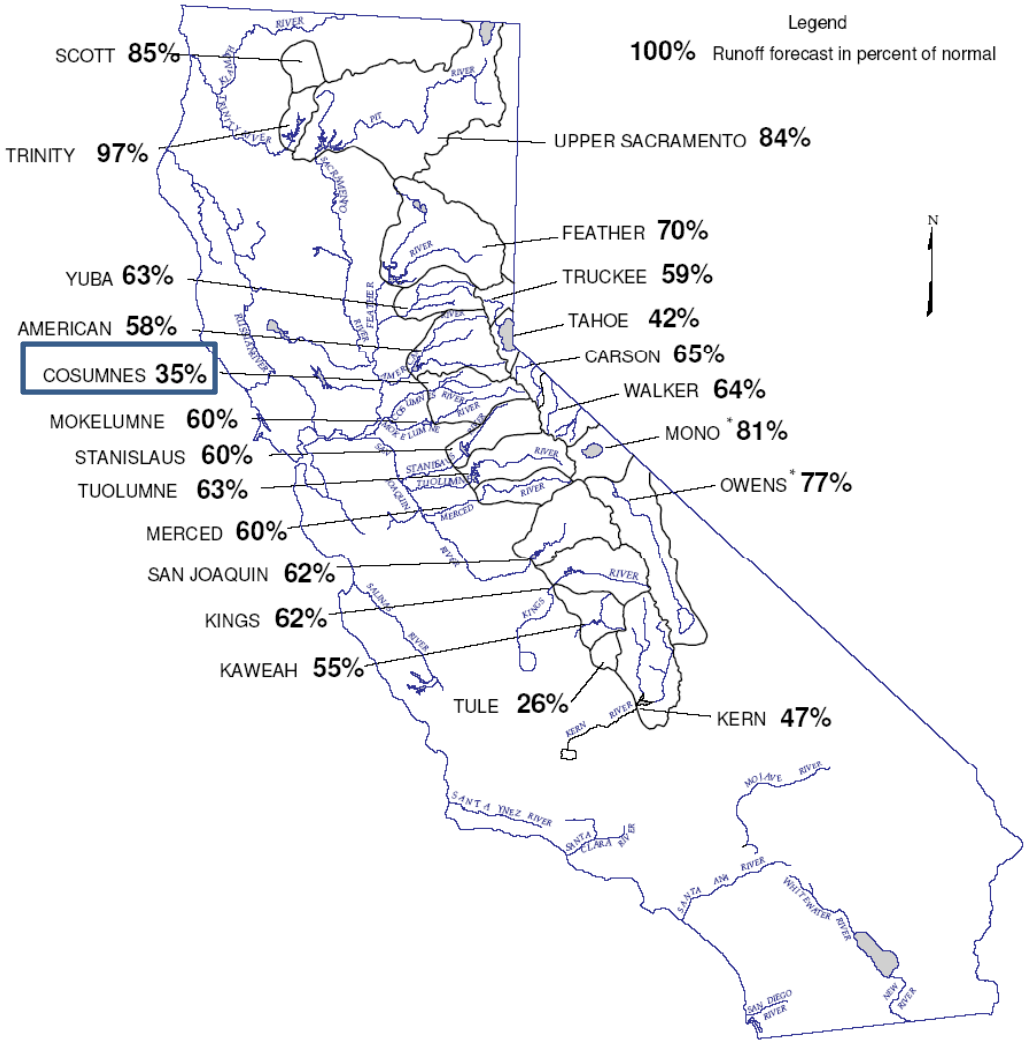
DEPARTMENT OF WATER RESOURCES

CALIFORNIA COOPERATIVE SNOW SURVEYS

FORECAST OF APRIL – JULY

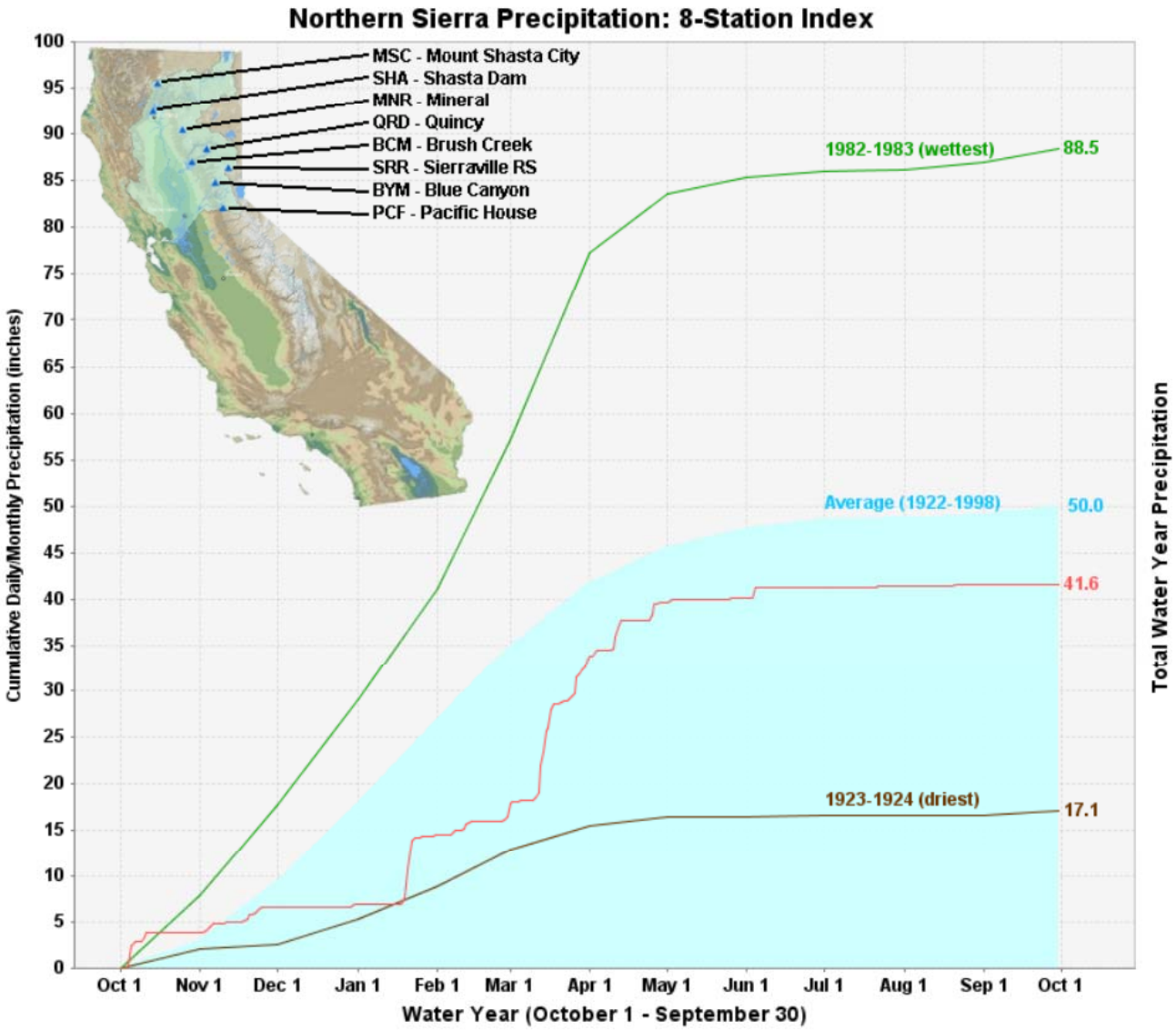
UNIMPAIRED SNOWMELT RUNOFF

May 1, 2004

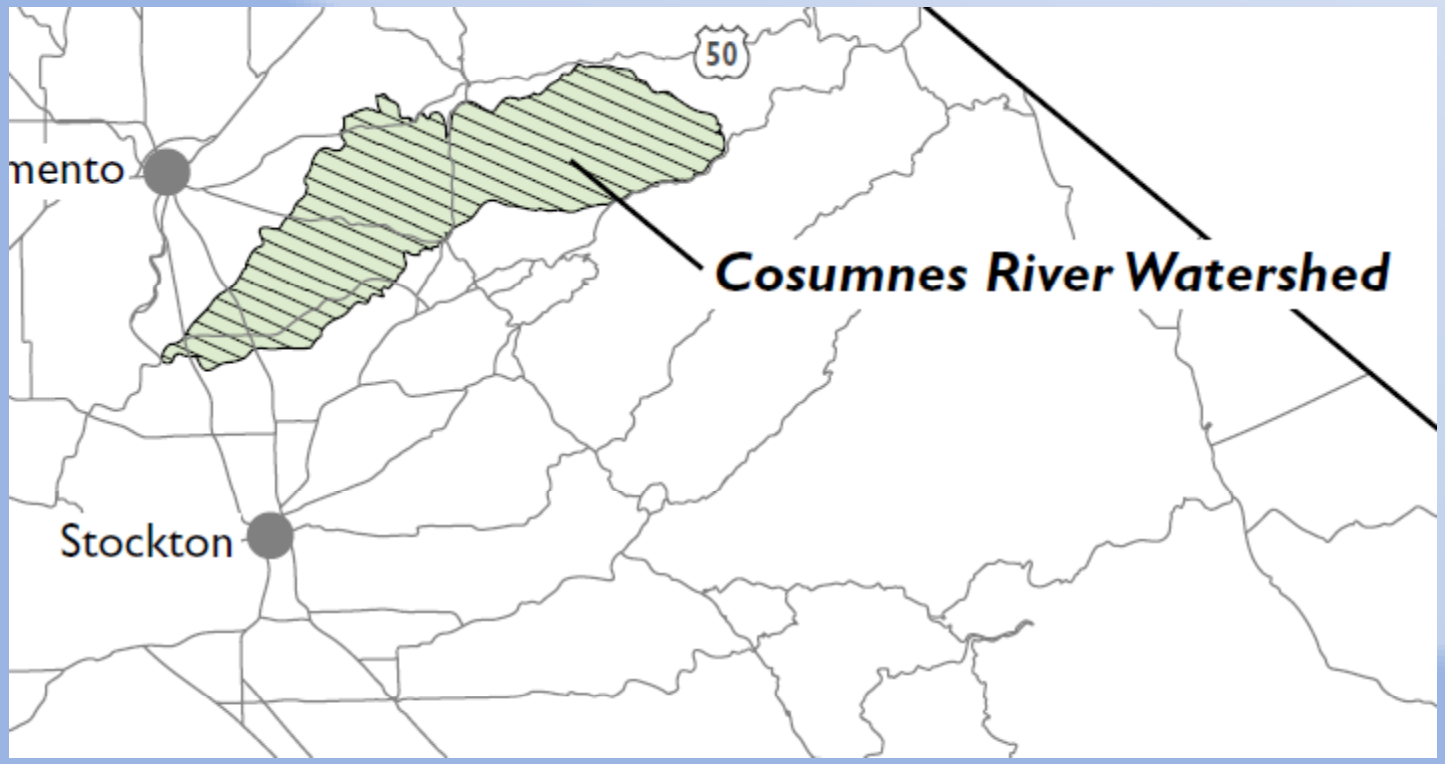


* FORECAST BY DEPARTMENT OF WATER AND POWER, CITY OF LOS ANGELES

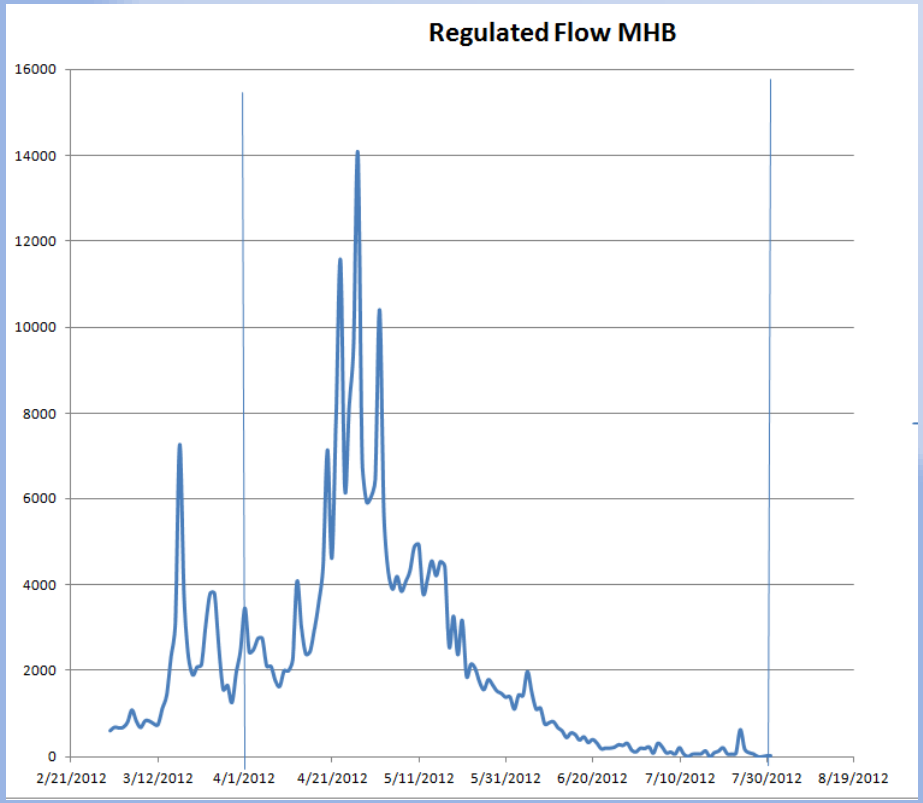
Water Year 2012
8 Station Index



Cosumnes, Michigan Bar	B120 A-J	% Error	FNF
April 1 Forecast	**50 taf**	**-52%**	**105taf**



Cosumnes, Michigan Bar	B120 A-J	% Error	FNF
April 1 Forecast	50taf	-52%	105taf
May 1 Forecast	**100taf**	**-5%**	**105taf**



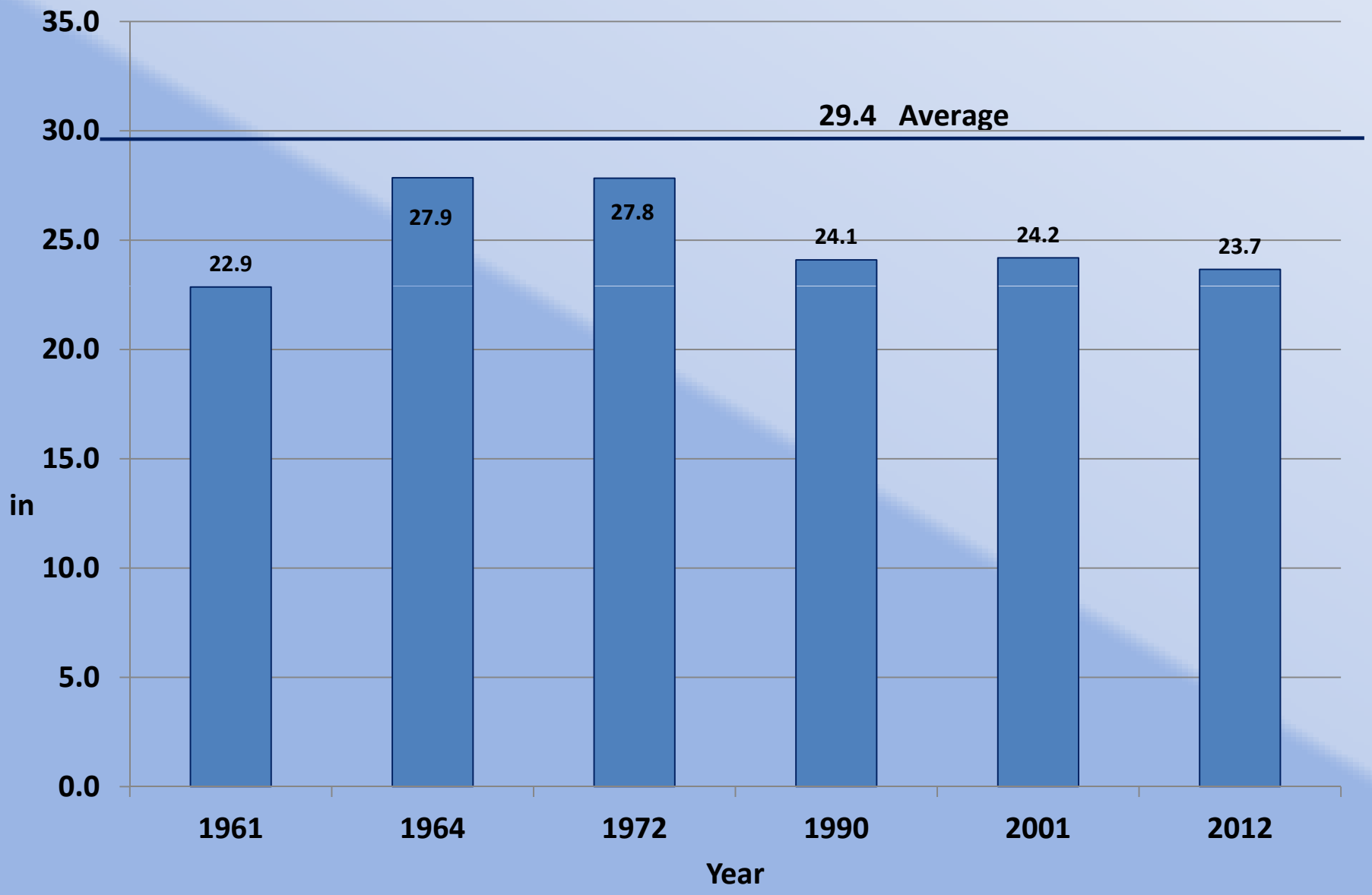
Cosumnes, Michigan Bar	B120 A-J	% Error	FNF
April 1 Forecast	50_{taf}	-52%	105_{taf}
May 1 Forecast	100_{taf}	-5%	105_{taf}
End of Season Verification	**59_{taf}**	**-44%**	**105_{taf}**

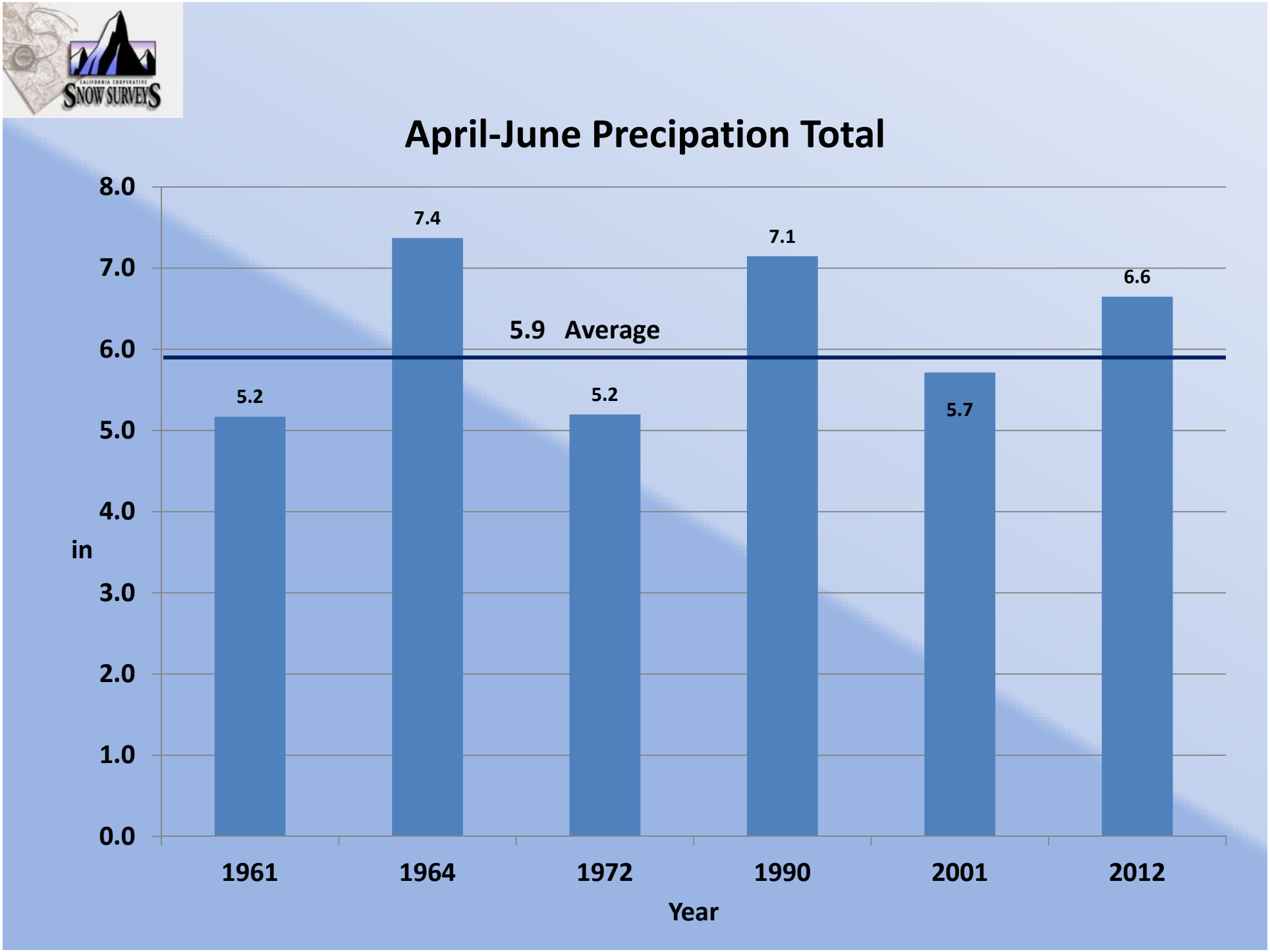
$$RO_{A-J}=.776S_{4/1}+.094P_{OM}+.0073P_{OM}^2+.00362P_{AJ}^2$$

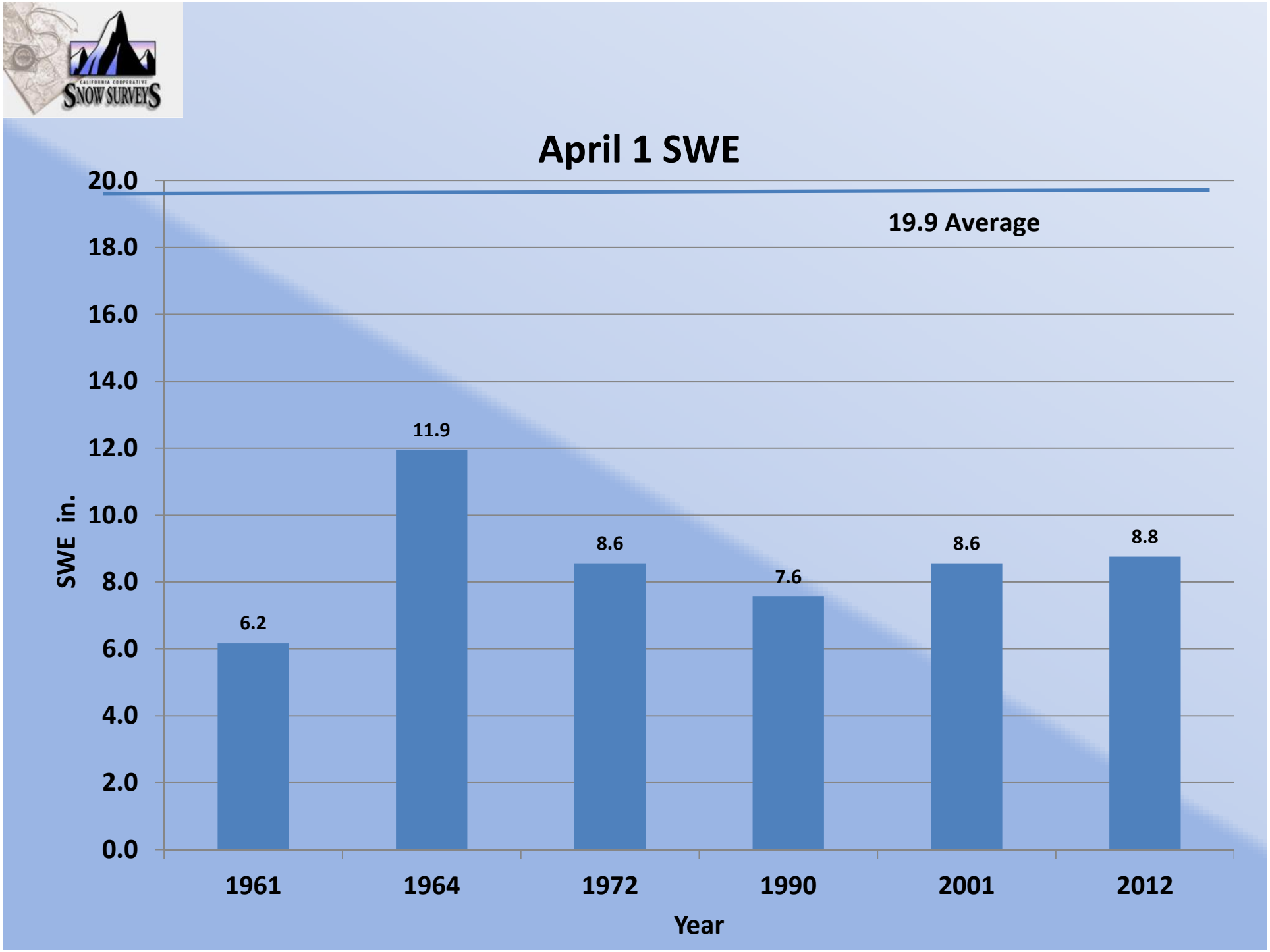
2012 $S_{4/1}$**=8.8 in** P_{OM}**=23.7 in** P_{AJ}**=6.6 in**

1961 1964 1972 1990 2001

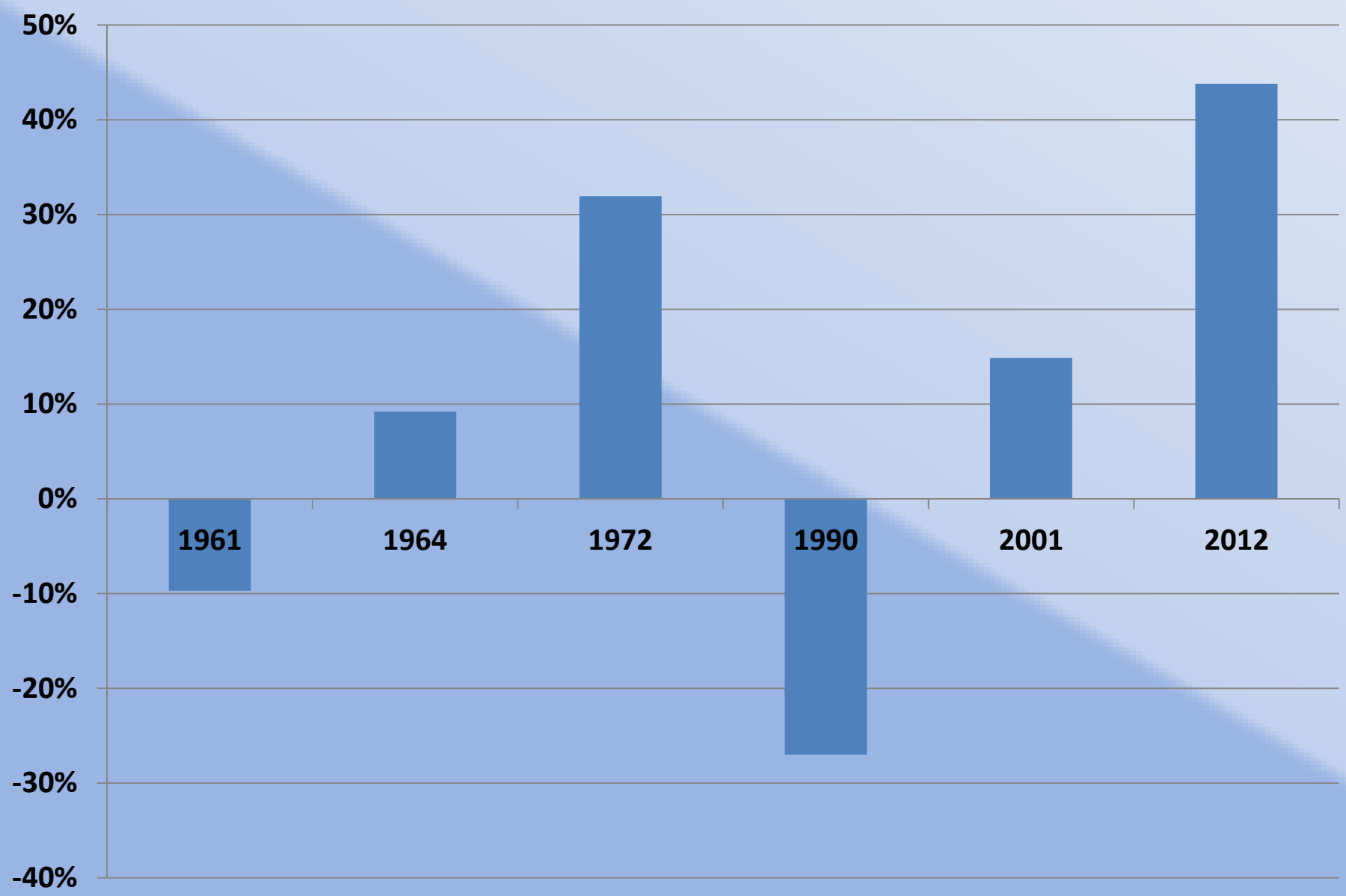
October-March Precipation Total



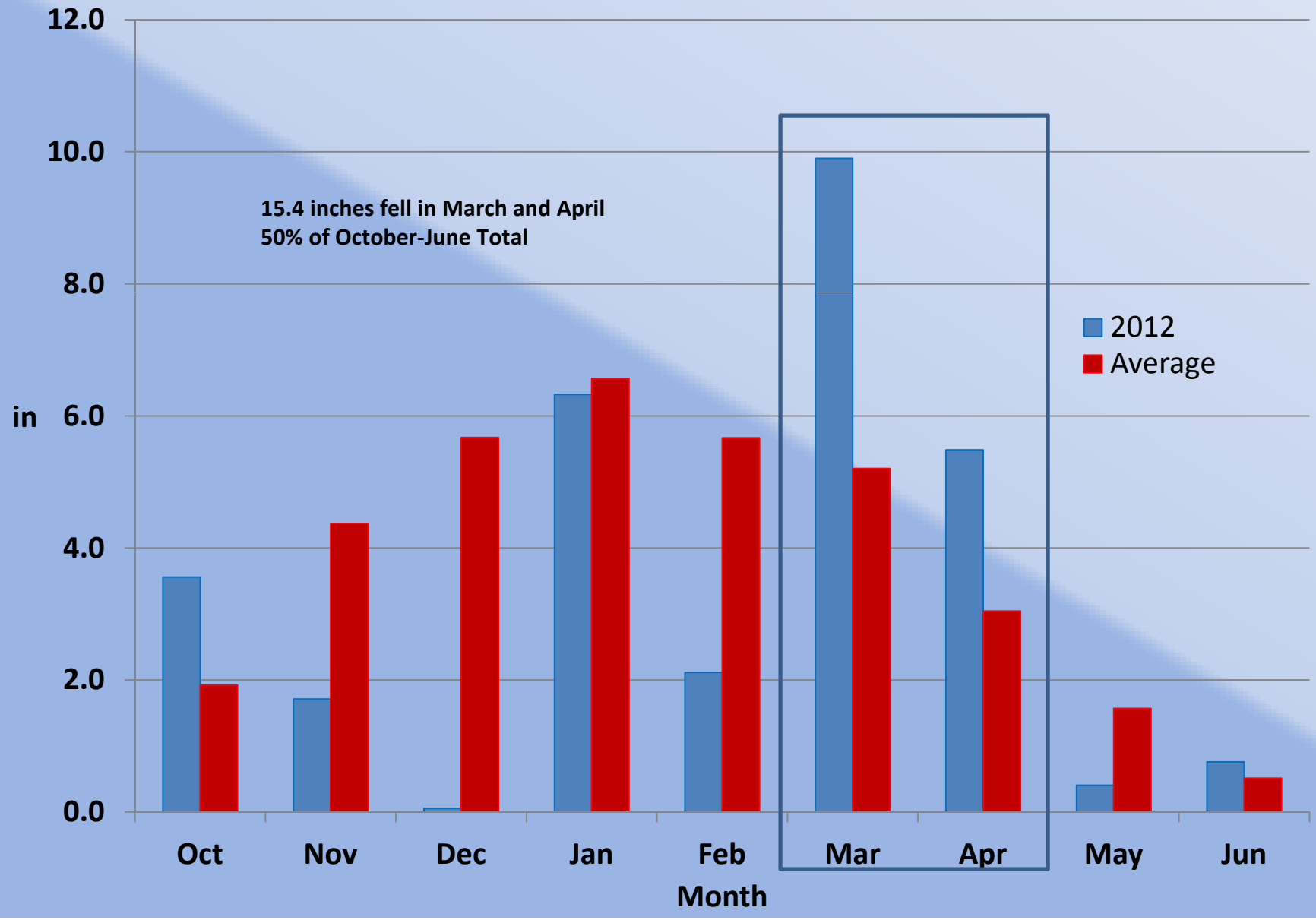

April-June Precipation Total
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
in
5.9 Average
5.2
7.4
5.2
7.1
5.7
6.6
1961
1964
1972
1990
2001
2012
Year


April 1 SWE
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
SWE in.
19.9 Average
6.2
11.9
8.6
7.6
8.6
8.8
1961
1964
1972
1990
2001
2012
Year

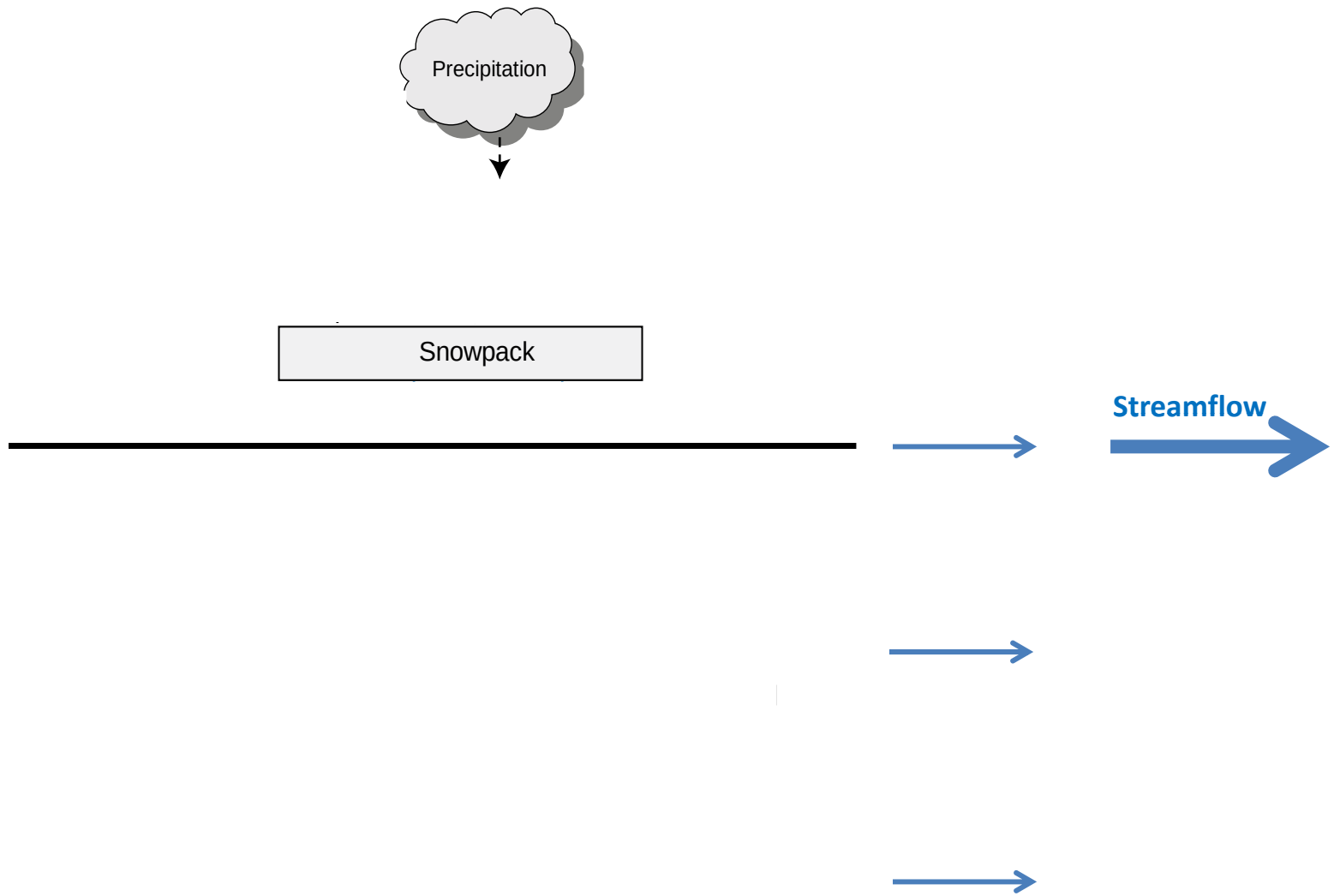
% A-J Forecast Error (End of Season)



October-June Precipation Distribution



Physical Properties Modeled with B120 Statistical Model

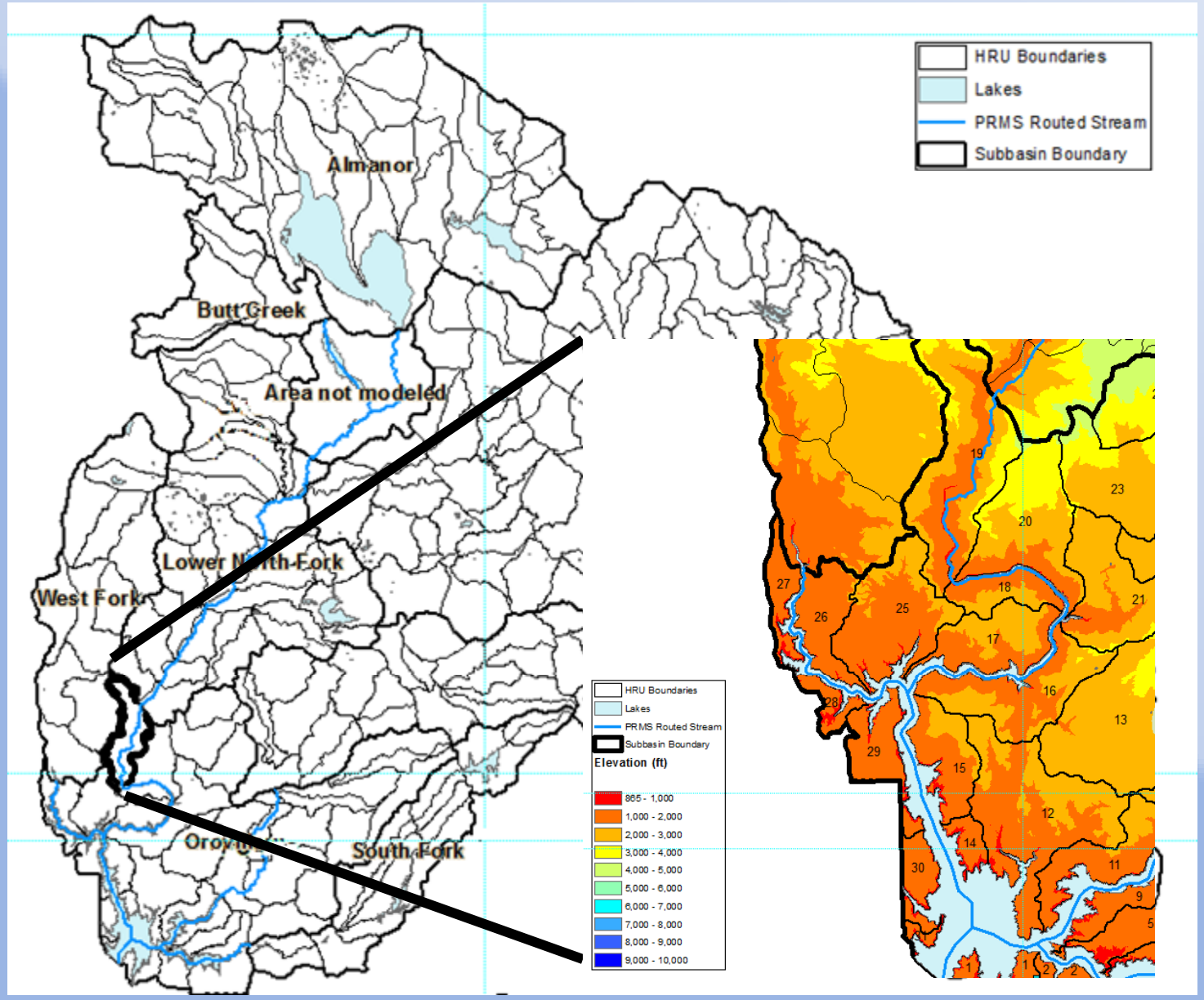


Benefits of PRMS Modeling: Feather River Subsurface Representation

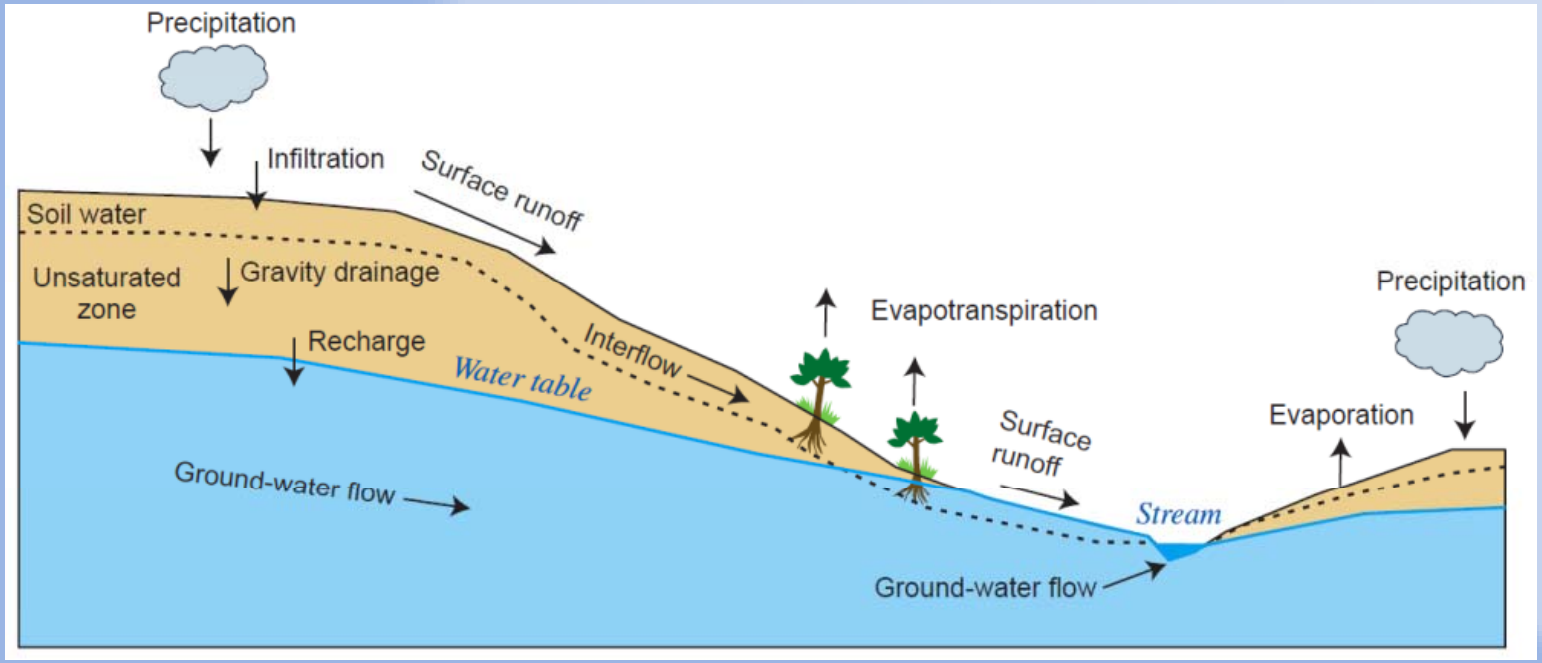
Khalida Fazel

PRMS Workgroup

Feather River Basin

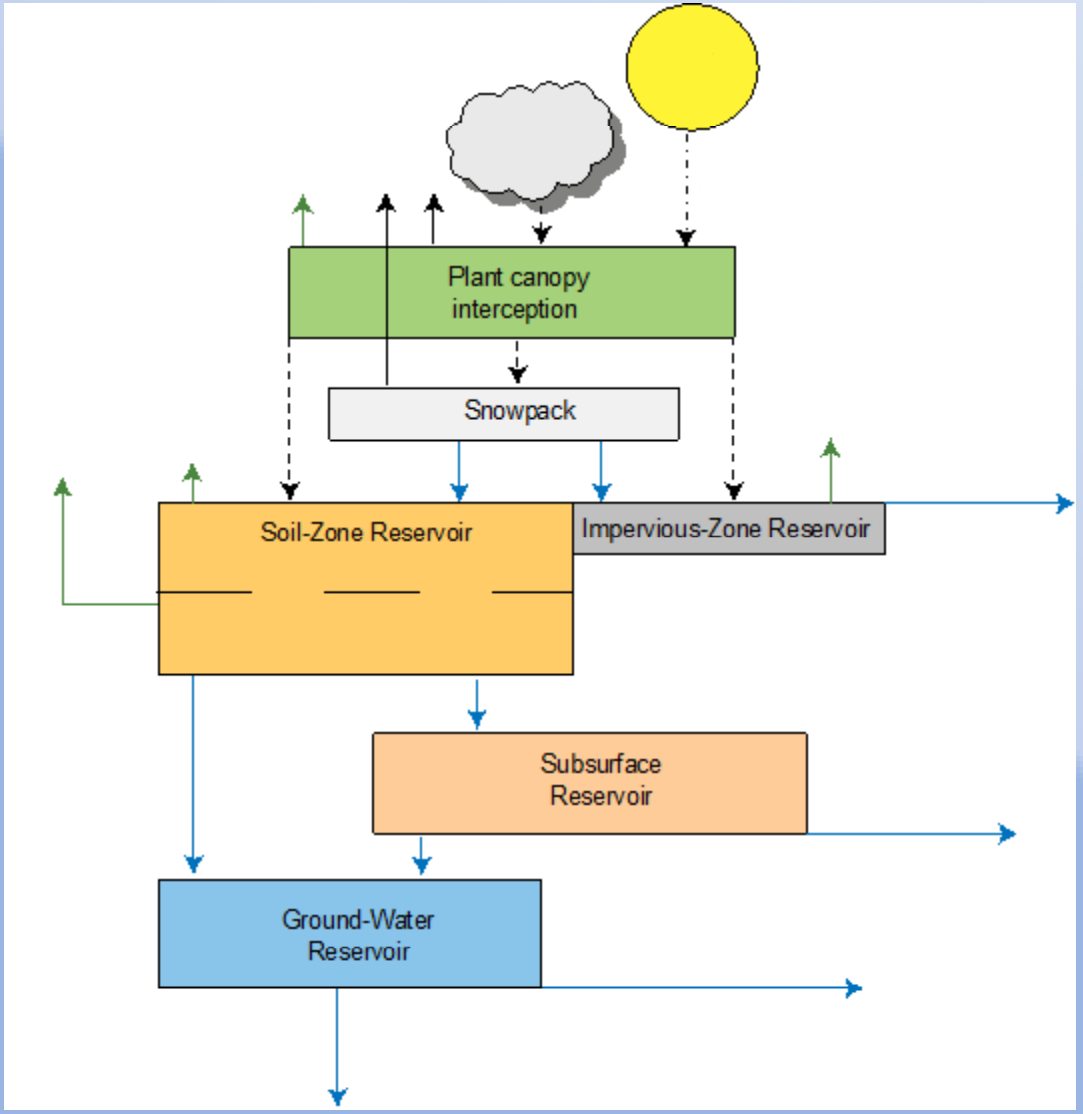


Feather PRMS Flow Processes at a Hillslope Cross-Section

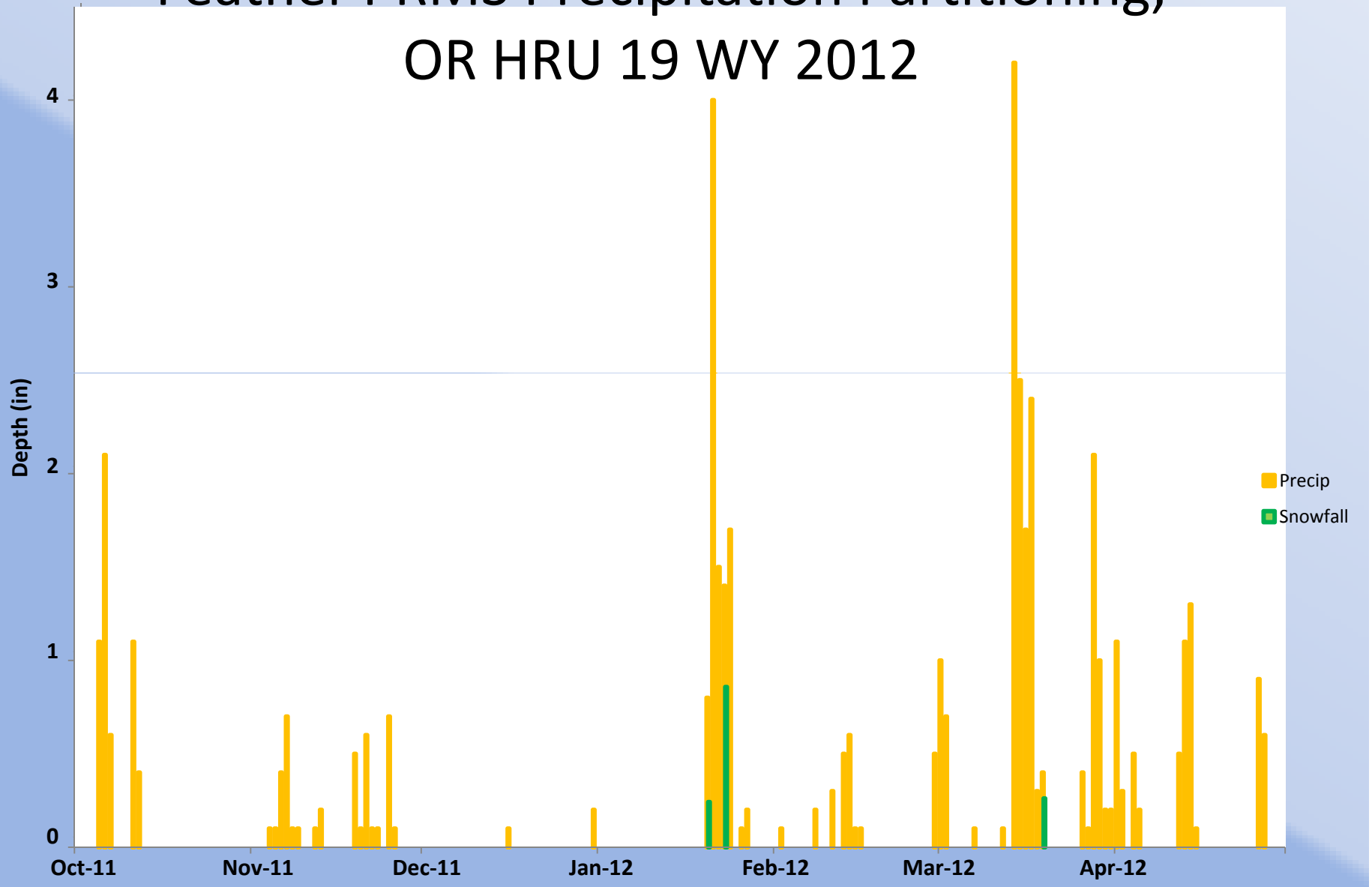


Source: USGS GSFlow Manual

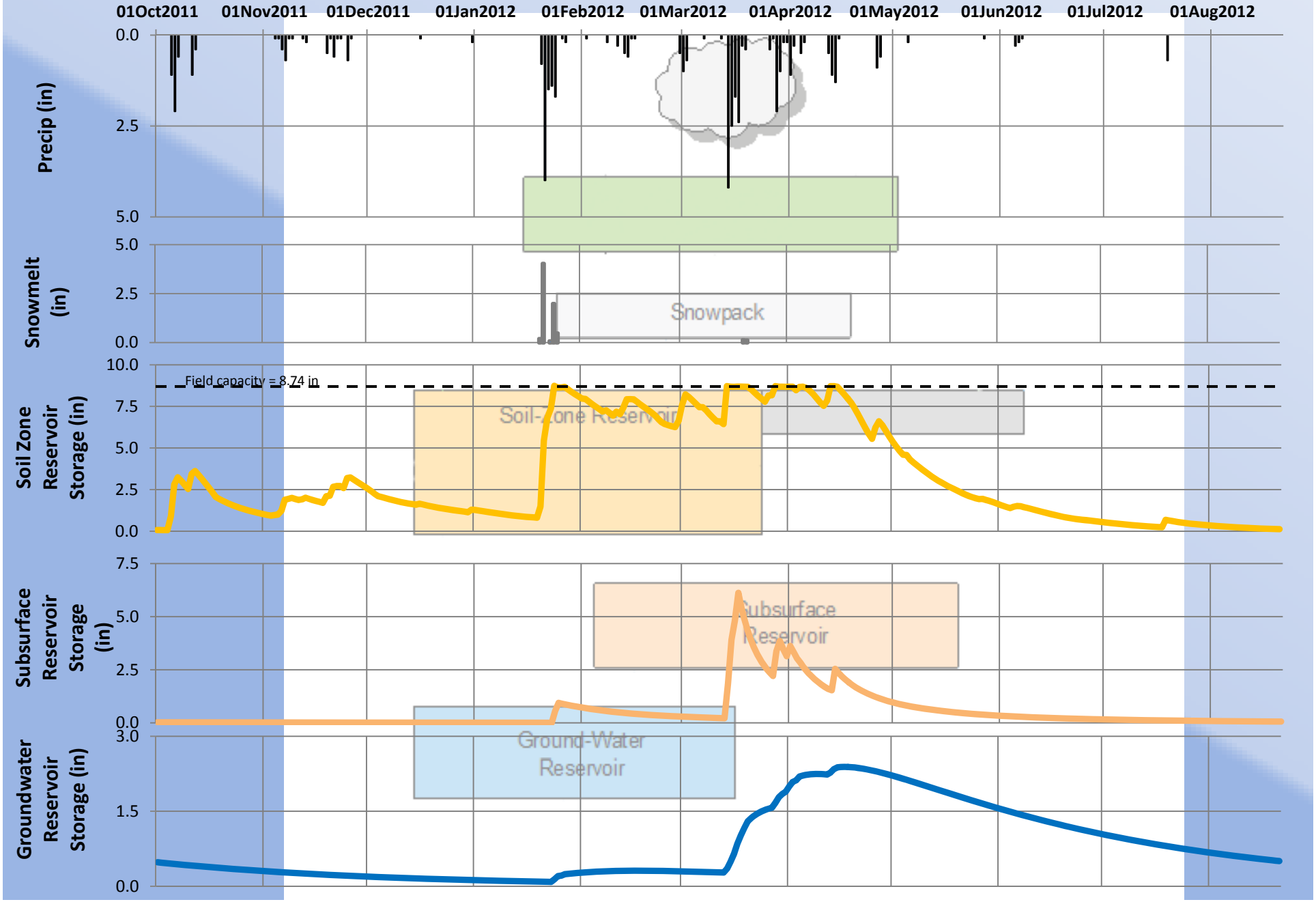
Feather PRMS Moisture Accounting Conceptualization



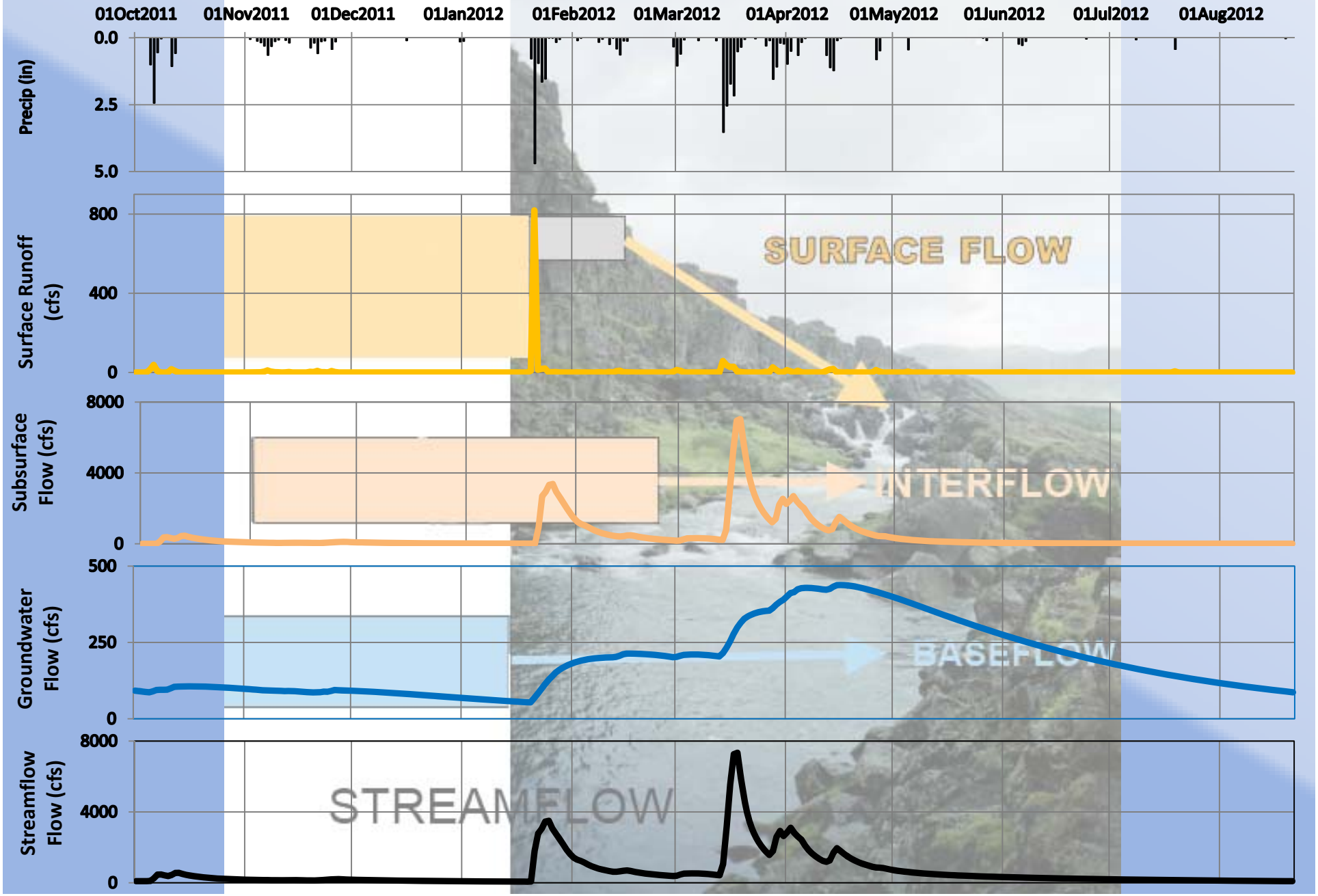
Feather PRMS Precipitation Partitioning, OR HRU 19 WY 2012



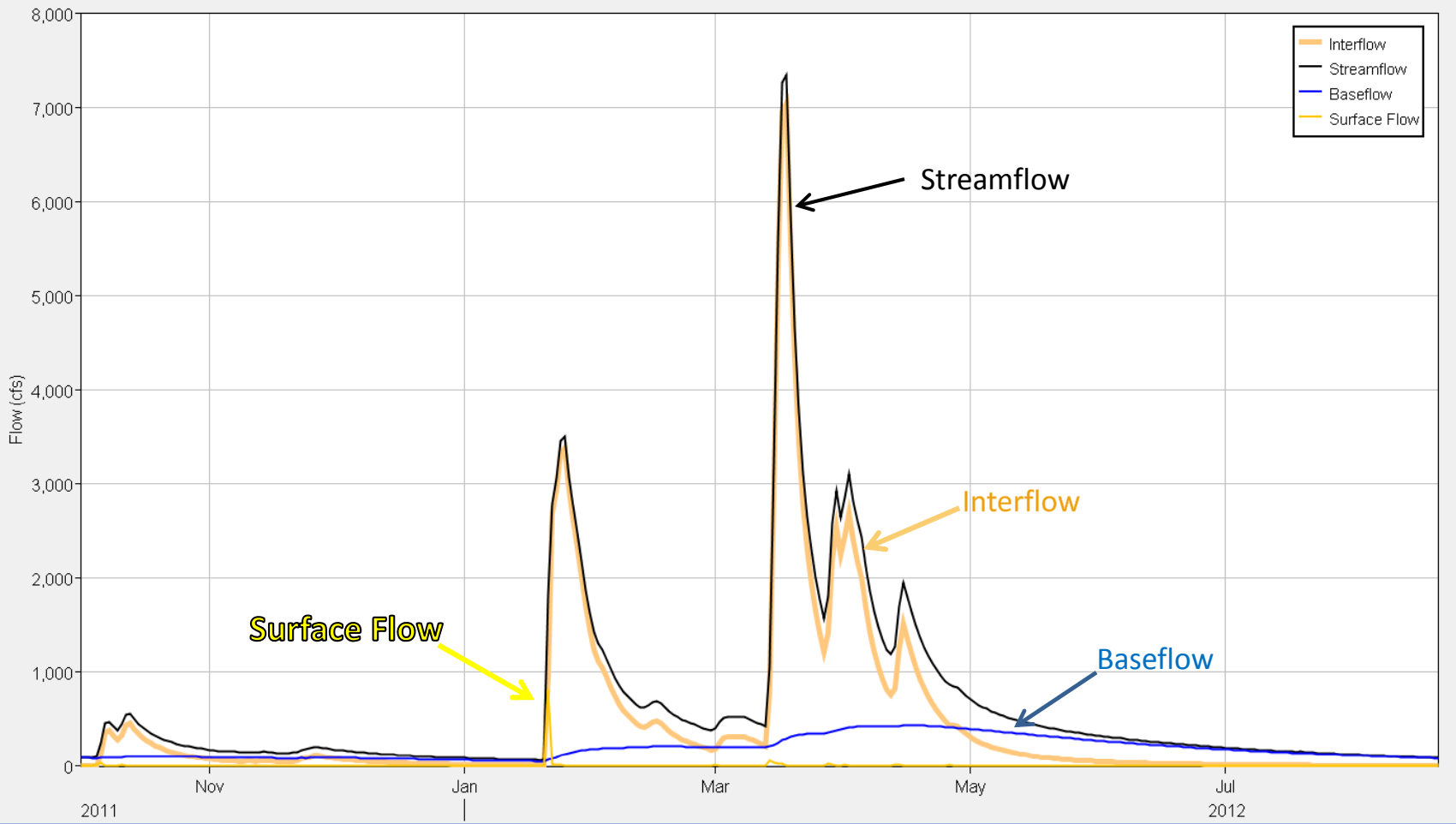
OR HRU 19 PRMS Moisture Accounting WY 2012



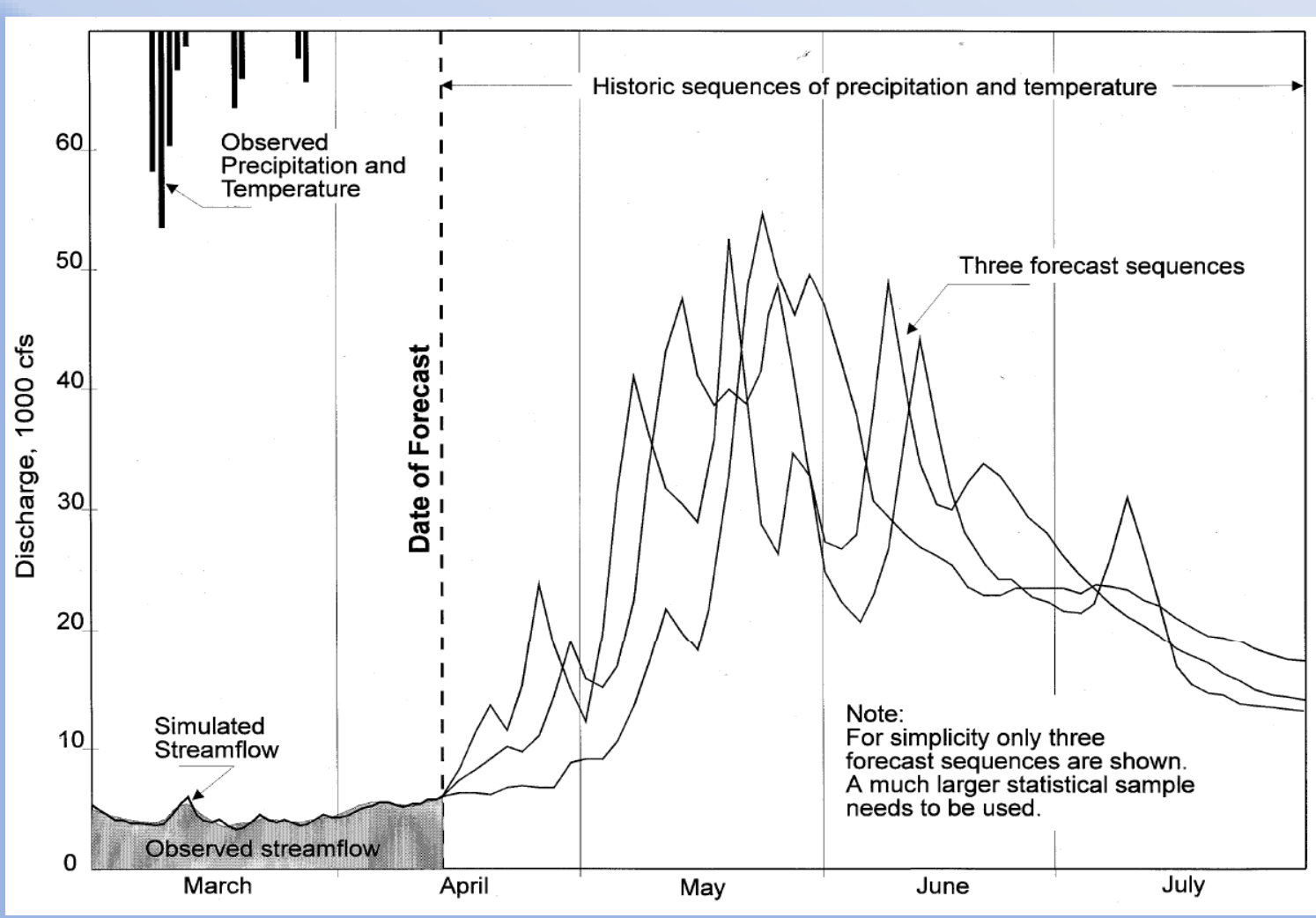
OR Subsurface Reservoir Outflow WY 2012



OR Streamflow Components WY 2012



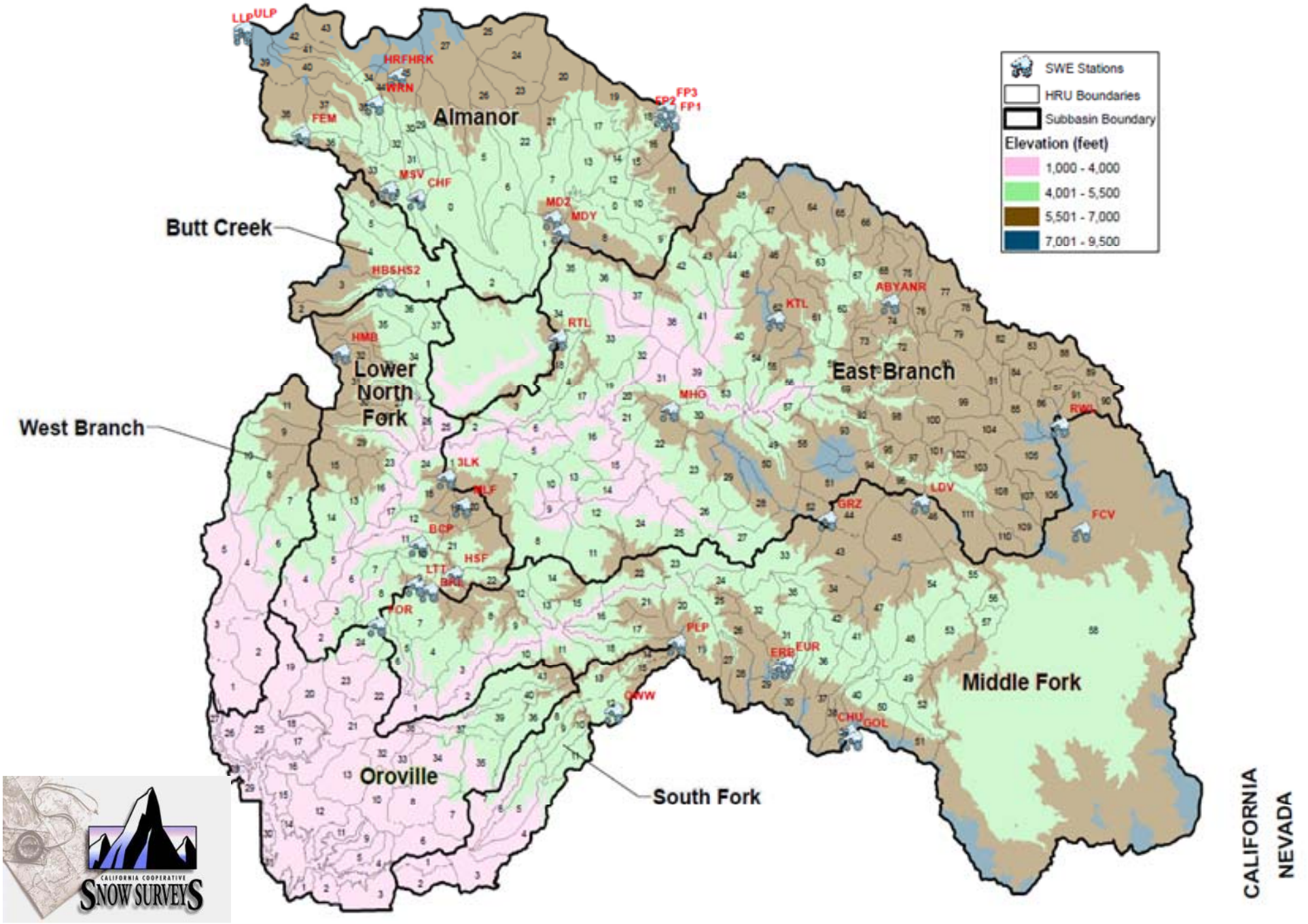
Forecasting with PRMS: Antecedent Conditions



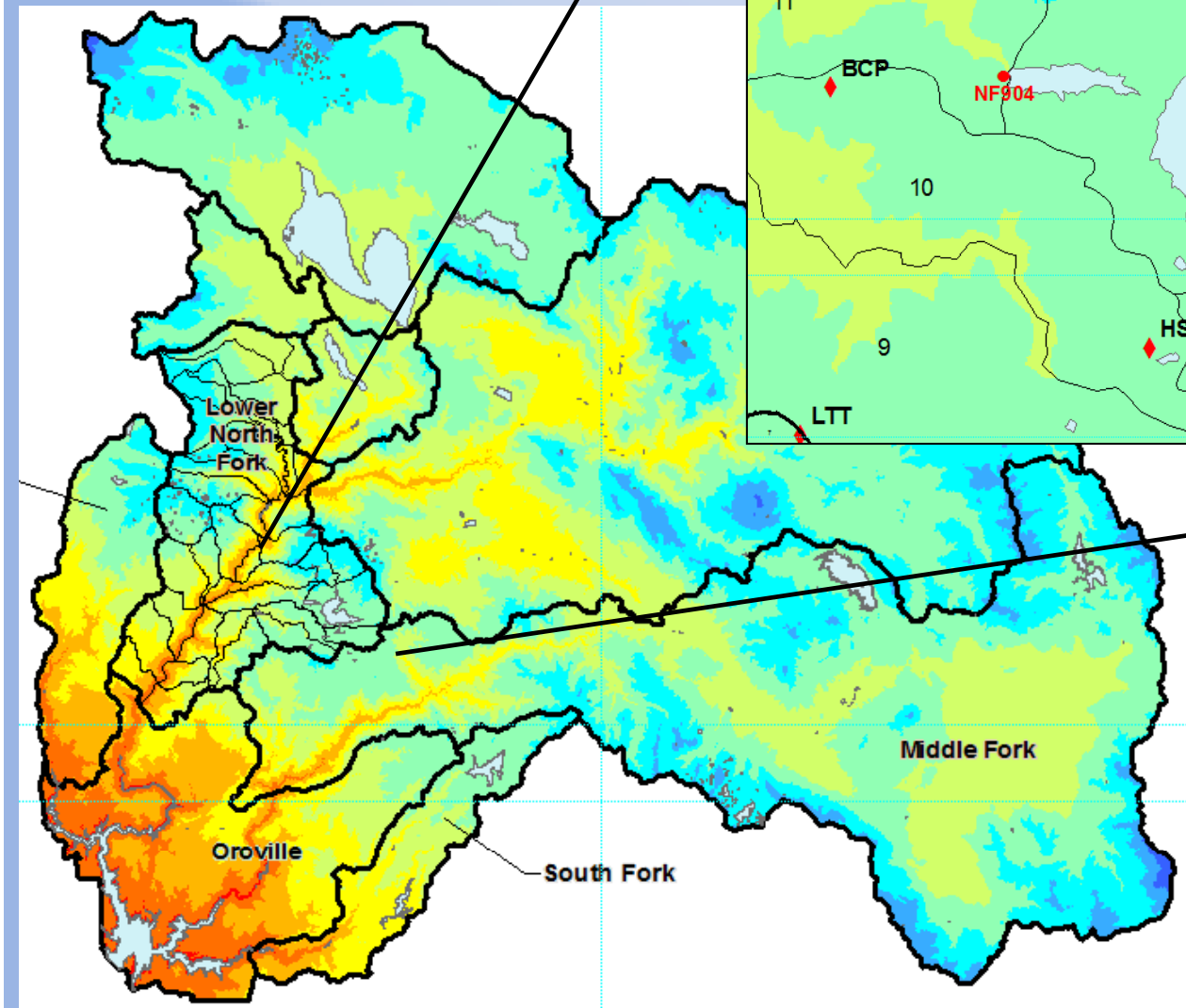
Source: EM 1110-2-1406

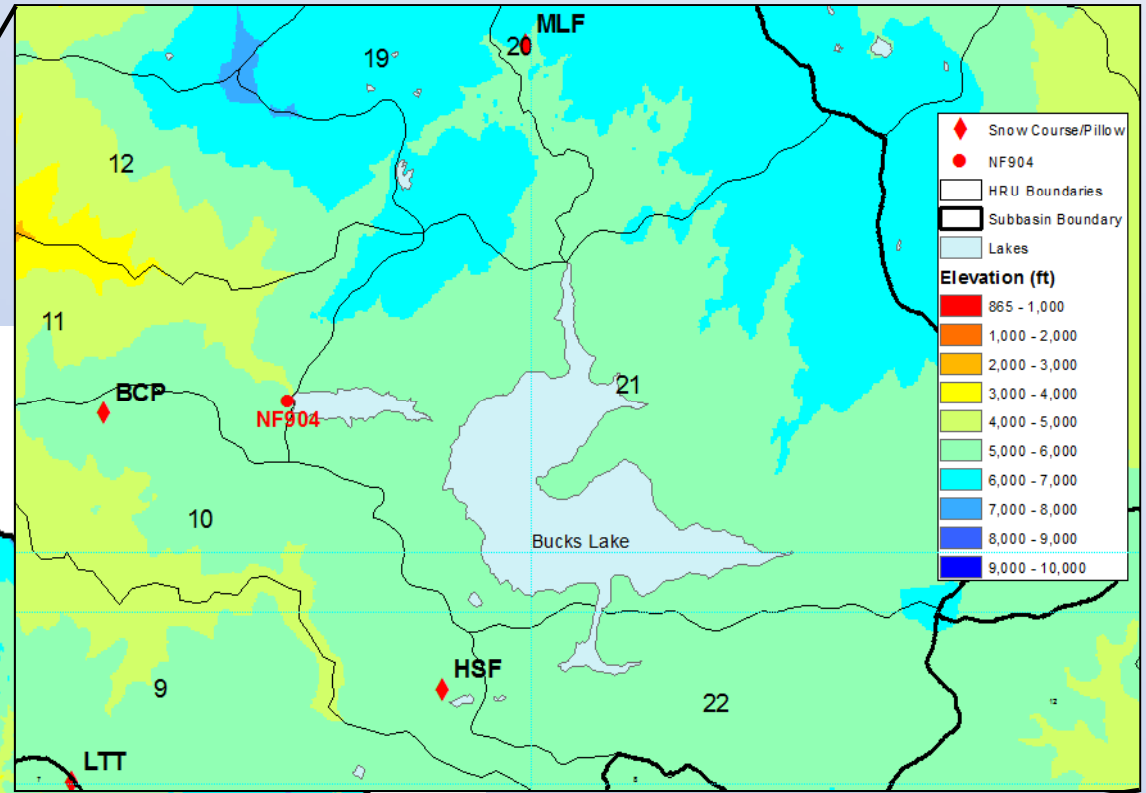
Conclusions

- Knowledge of storage in each subsurface reservoir and the ability to quantify input as either rain or snowmelt can better inform forecast
- PRMS provides a representation of streamflow and its contributing components
- Extreme/unusual events can be better represented in a distributed, conceptual model (PRMS), compared to statistical approaches (Bulletin 120)

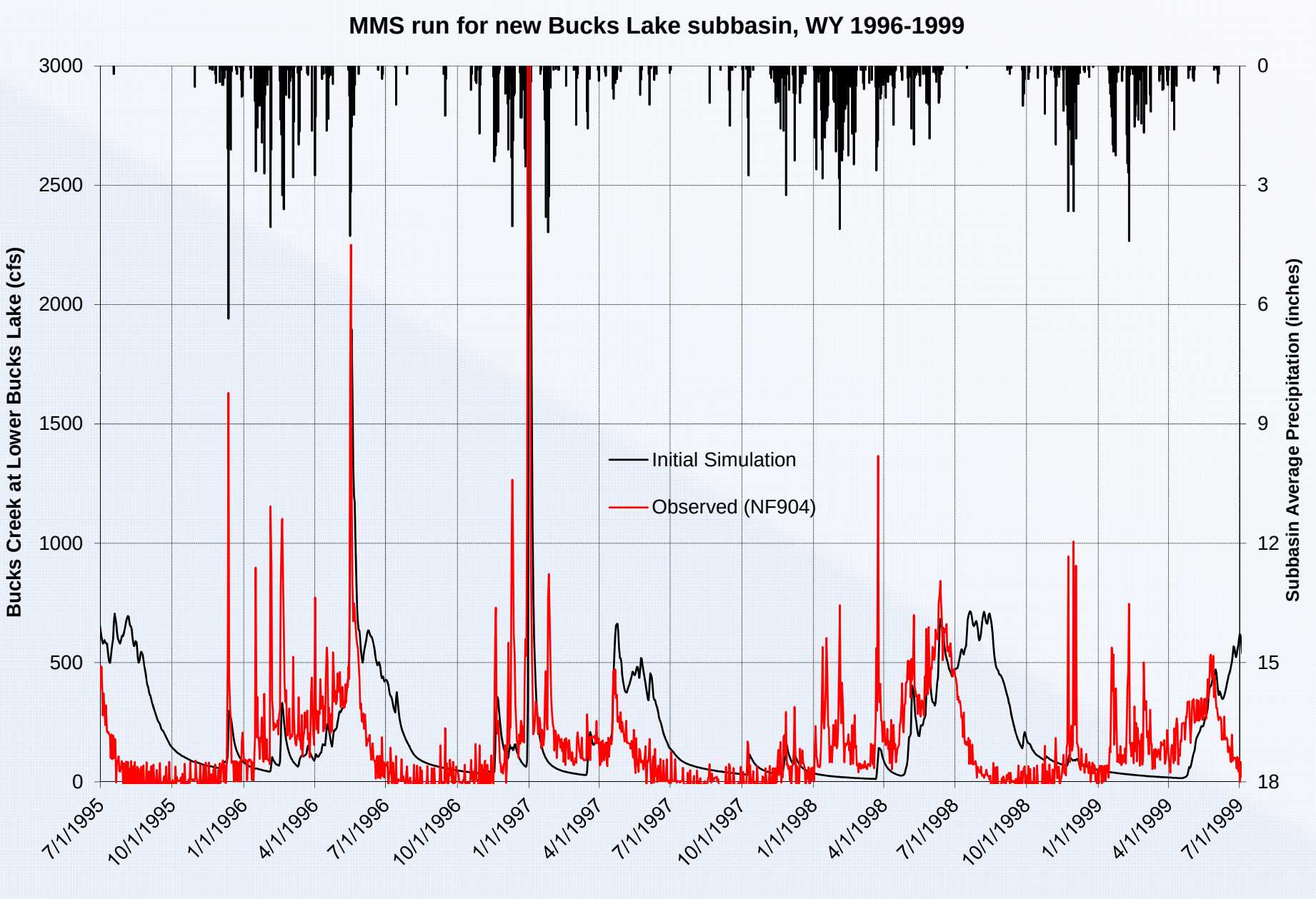

SWE Stations
HRU Boundaries
Subbasin Boundary
Elevation (feet)
1,000 - 4,000
4,001 - 5,500
5,501 - 7,000
7,001 - 9,500
Almanor
Butt Creek
West Branch
Lower North Fork
East Branch
Middle Fork
Oroville
South Fork
CALIFORNIA
NEVADA
LLP
ULP
HRF
HRK
WRN
FEM
FP3
FP2
FP1
MSV
CHF
MD2
MDY
HBS
HS2
HMB
RTL
KTL
ABY
ANR
MHG
RWL
3LK
NLF
BCP
HSF
LTT
BRE
FOR
GRZ
LDV
FCV
PLP
ERB
EUR
CHU
GOL
GNW

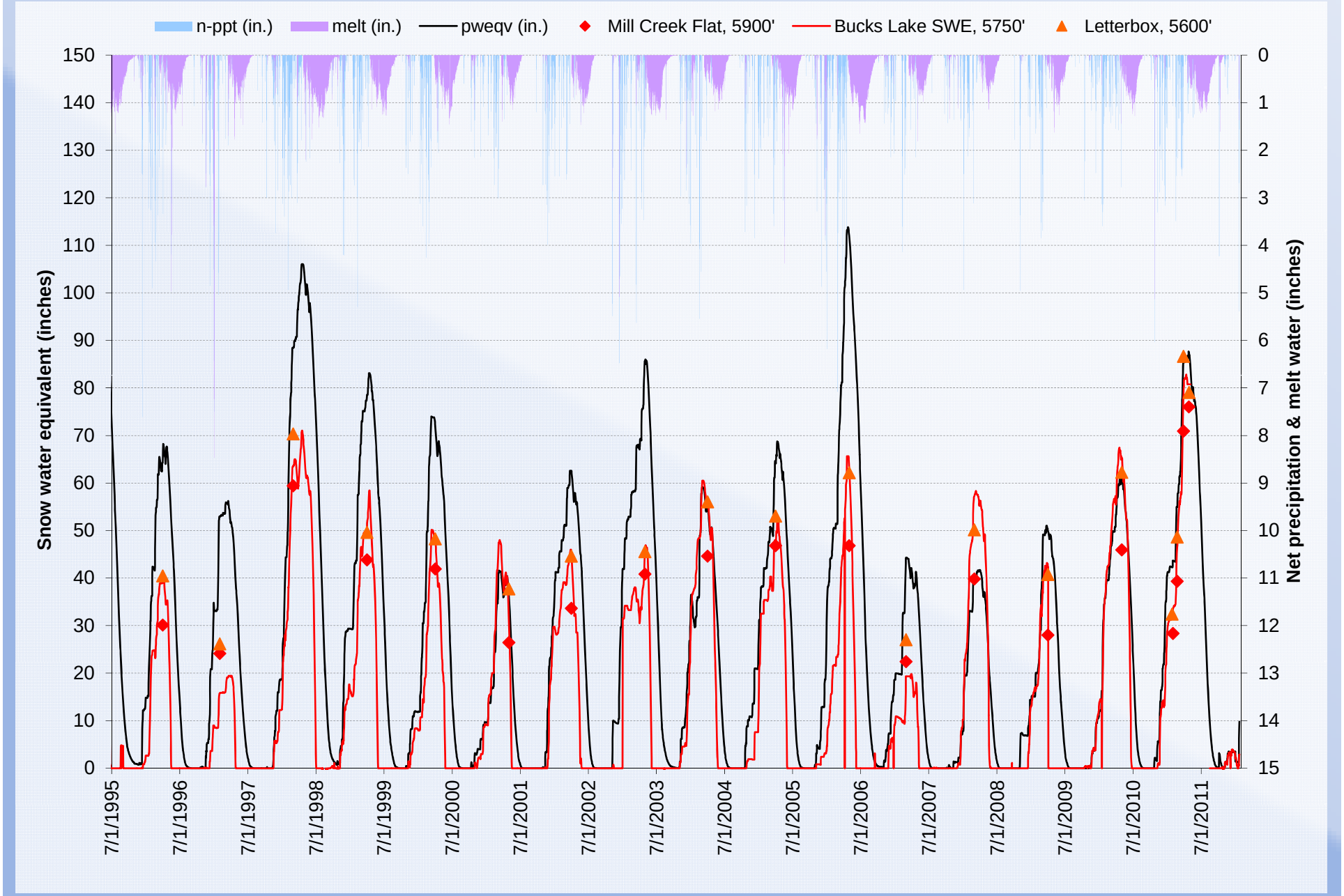
Lower North Fork

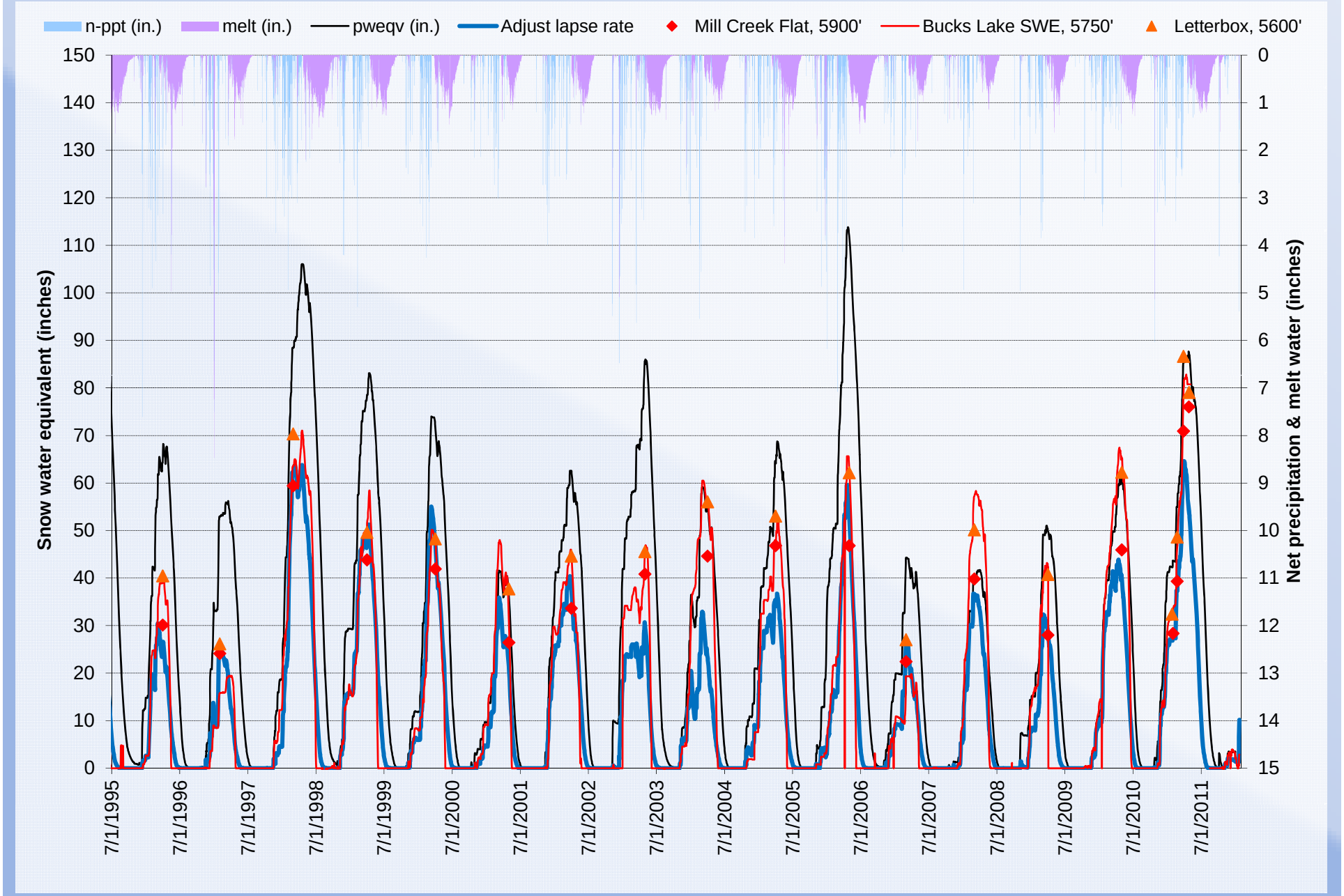


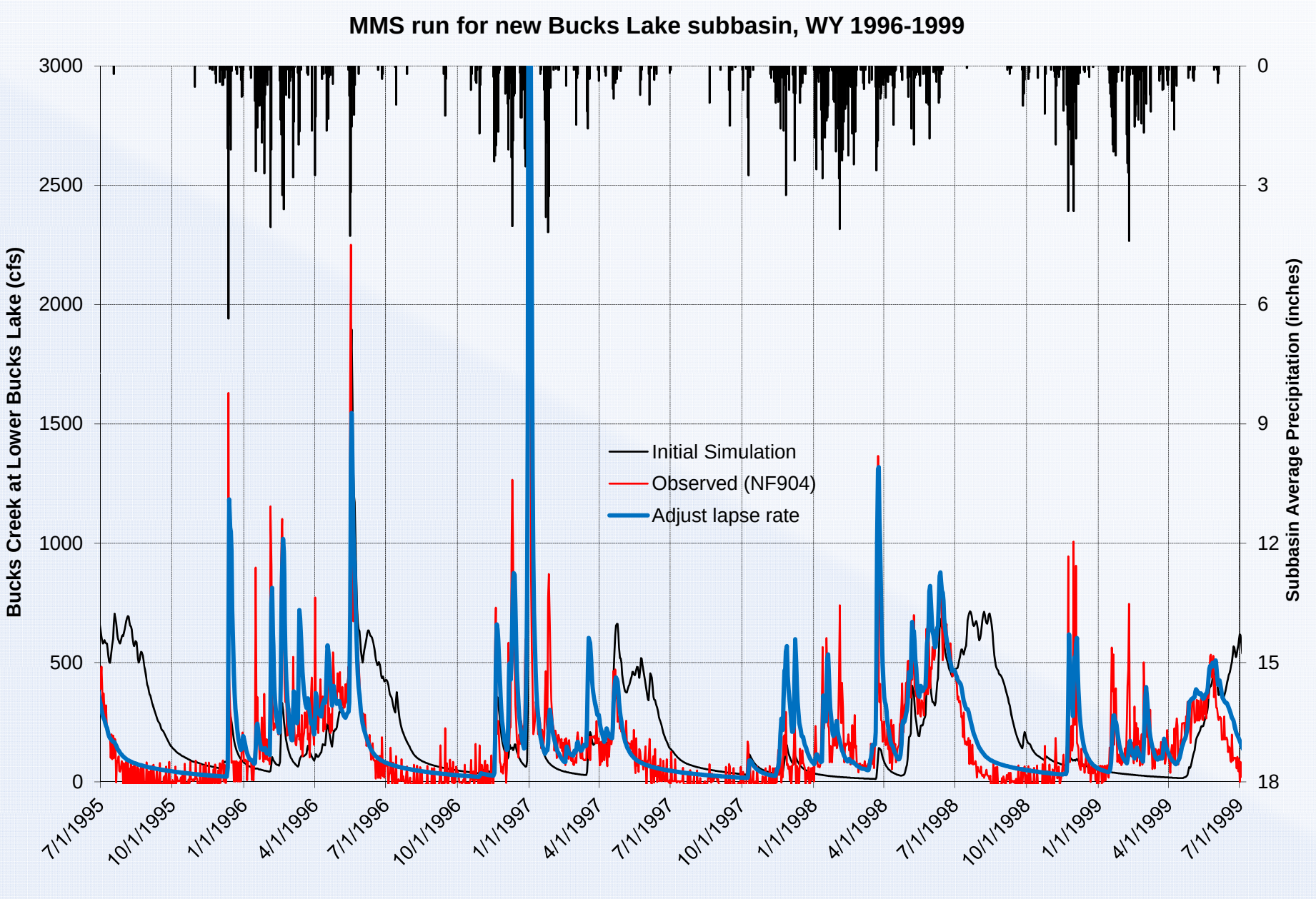


CALIFORNIA COOPERATIVE SNOW SURVEYS

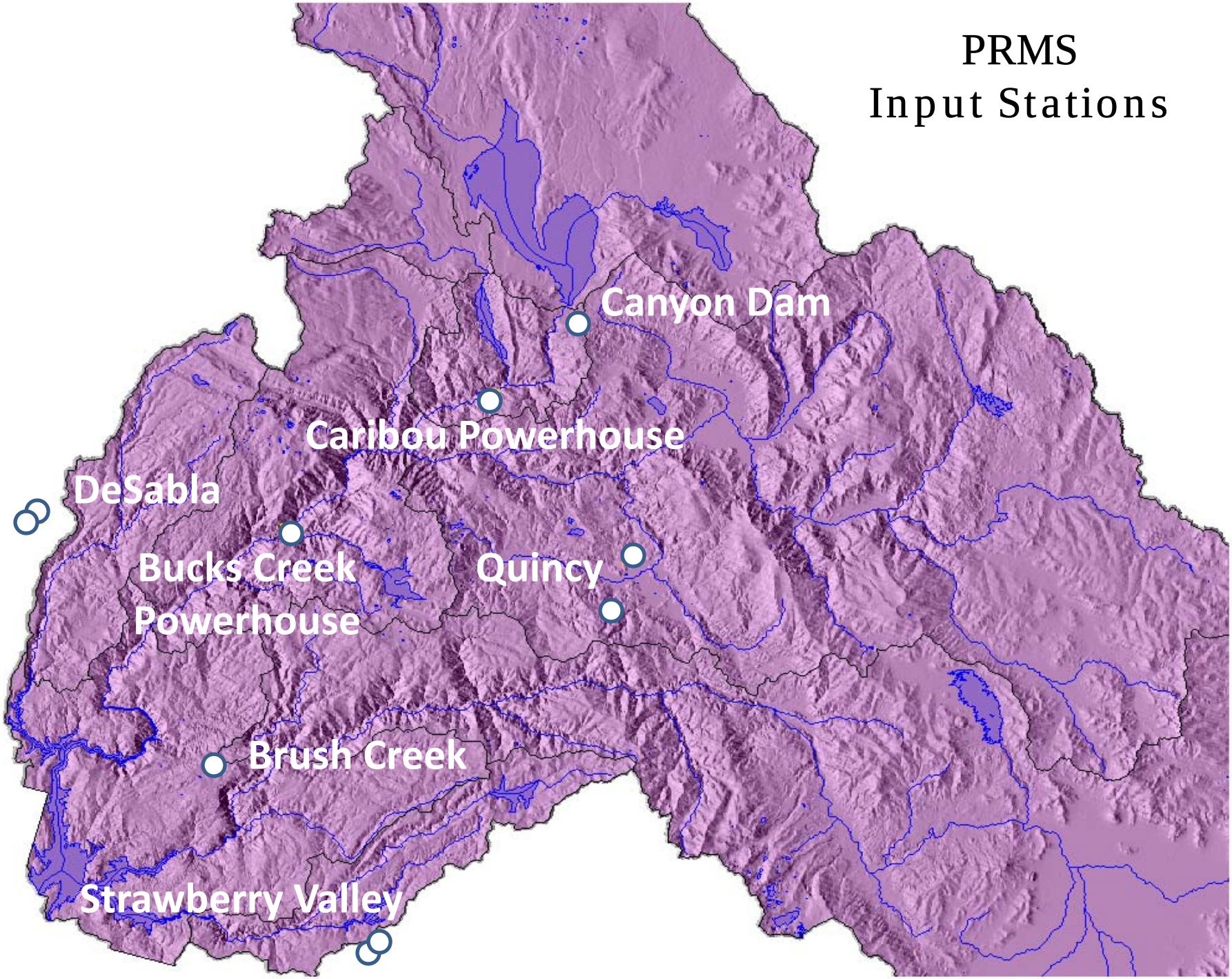

MMS run for new Bucks Lake subbasin, WY 1996-1999
Bucks Creek at Lower Bucks Lake (cfs)
Subbasin Average Precipitation (inches)
3000
2500
2000
1500
1000
500
0
0
3
6
9
12
15
18
Initial Simulation
Observed (NF904)
7/1/1995
10/1/1995
1/1/1996
4/1/1996
7/1/1996
10/1/1996
1/1/1997
4/1/1997
7/1/1997
10/1/1997
1/1/1998
4/1/1998
7/1/1998
10/1/1998
1/1/1999
4/1/1999
7/1/1999


n-ppt (in.)
melt (in.)
pweqv (in.)
Mill Creek Flat, 5900'
Bucks Lake SWE, 5750'
Letterbox, 5600'
Snow water equivalent (inches)
Net precipitation & melt water (inches)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
7/1/1995
7/1/1996
7/1/1997
7/1/1998
7/1/1999
7/1/2000
7/1/2001
7/1/2002
7/1/2003
7/1/2004
7/1/2005
7/1/2006
7/1/2007
7/1/2008
7/1/2009
7/1/2010
7/1/2011


n-ppt (in.)
melt (in.)
pweqv (in.)
Adjust lapse rate
Mill Creek Flat, 5900'
Bucks Lake SWE, 5750'
Letterbox, 5600'
Snow water equivalent (inches)
Net precipitation & melt water (inches)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
7/1/1995
7/1/1996
7/1/1997
7/1/1998
7/1/1999
7/1/2000
7/1/2001
7/1/2002
7/1/2003
7/1/2004
7/1/2005
7/1/2006
7/1/2007
7/1/2008
7/1/2009
7/1/2010
7/1/2011


MMS run for new Bucks Lake subbasin, WY 1996-1999
Bucks Creek at Lower Bucks Lake (cfs)
Subbasin Average Precipitation (inches)
3000
2500
2000
1500
1000
500
0
0
3
6
9
12
15
18
Initial Simulation
Observed (NF904)
Adjust lapse rate
7/1/1995
10/1/1995
1/1/1996
4/1/1996
7/1/1996
10/1/1996
1/1/1997
4/1/1997
7/1/1997
10/1/1997
1/1/1998
4/1/1998
7/1/1998
10/1/1998
1/1/1999
4/1/1999
7/1/1999

PRMS
Input Stations



PRMS

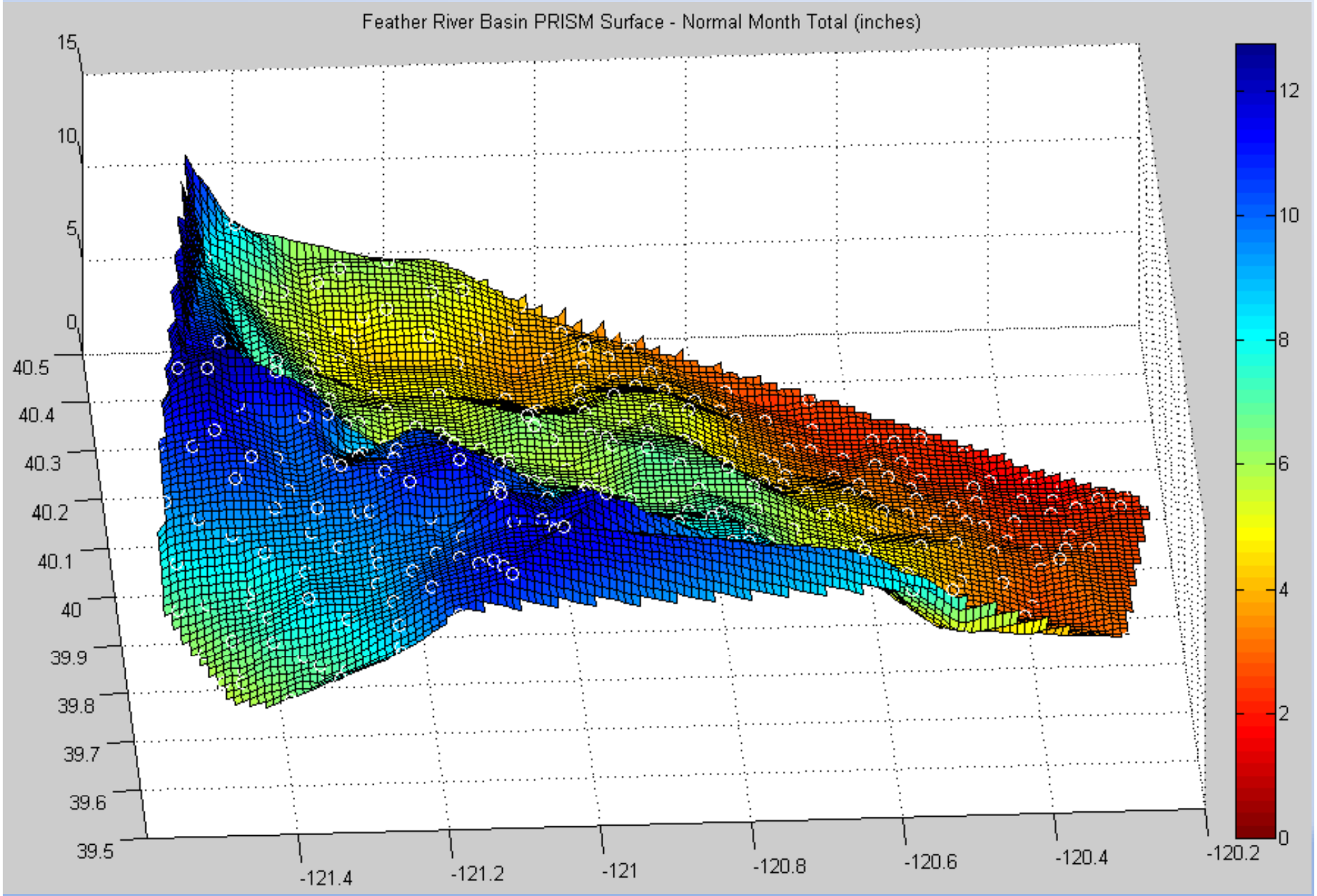
Precipitation Runoff Modeling System

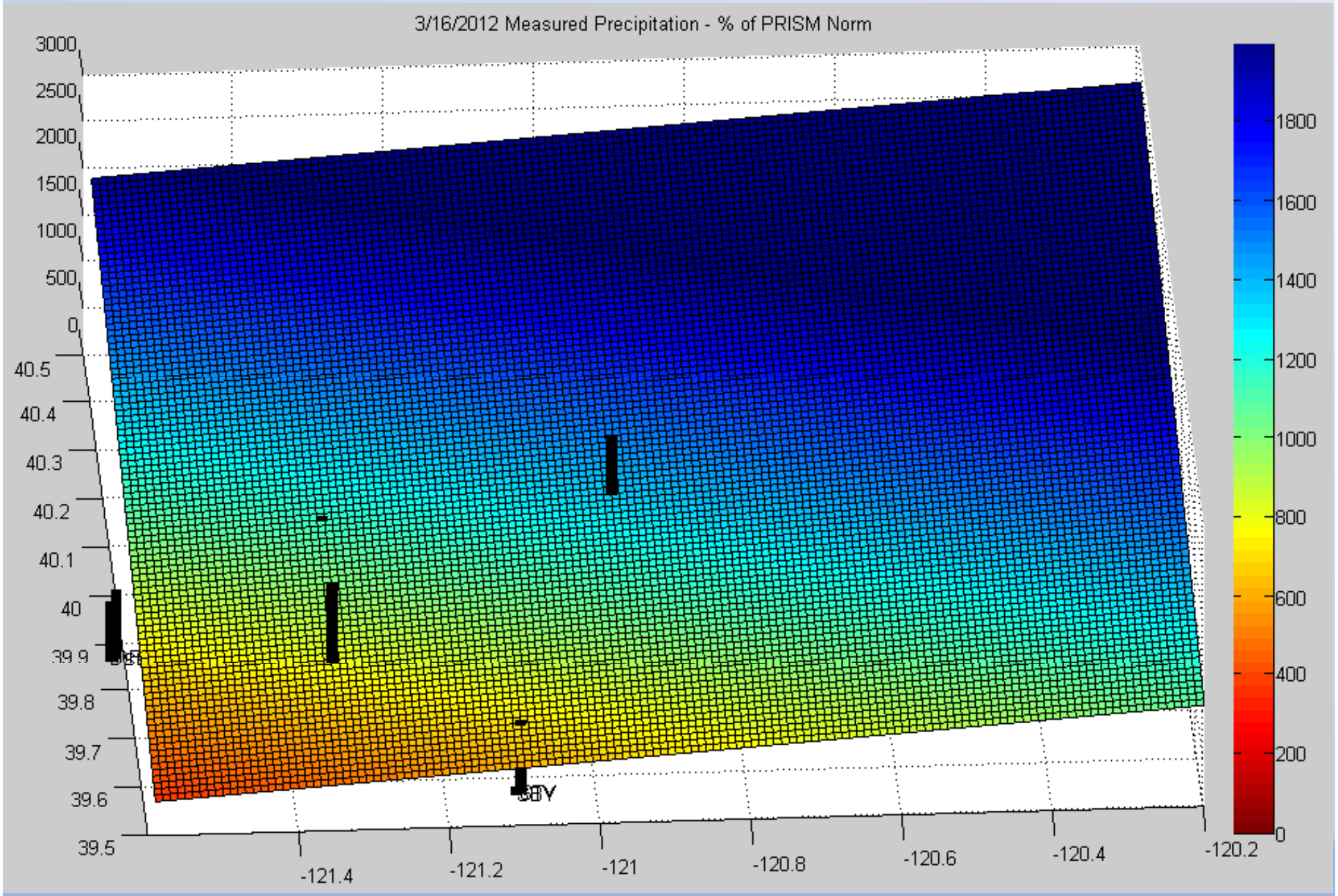
http://wwwbrr.cr.usgs.gov/projects/SW_MoWS/PRMS.html

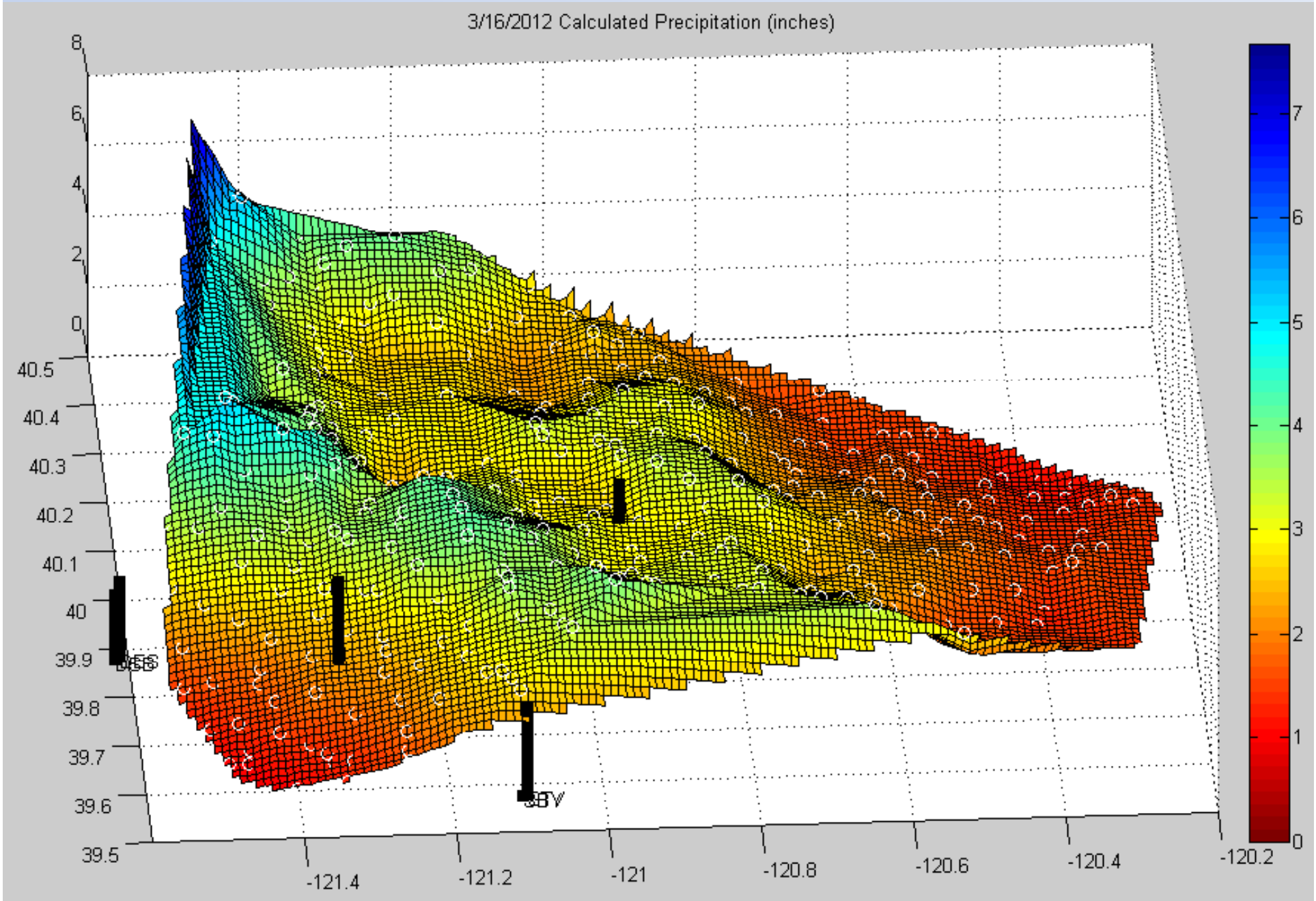
PRISM

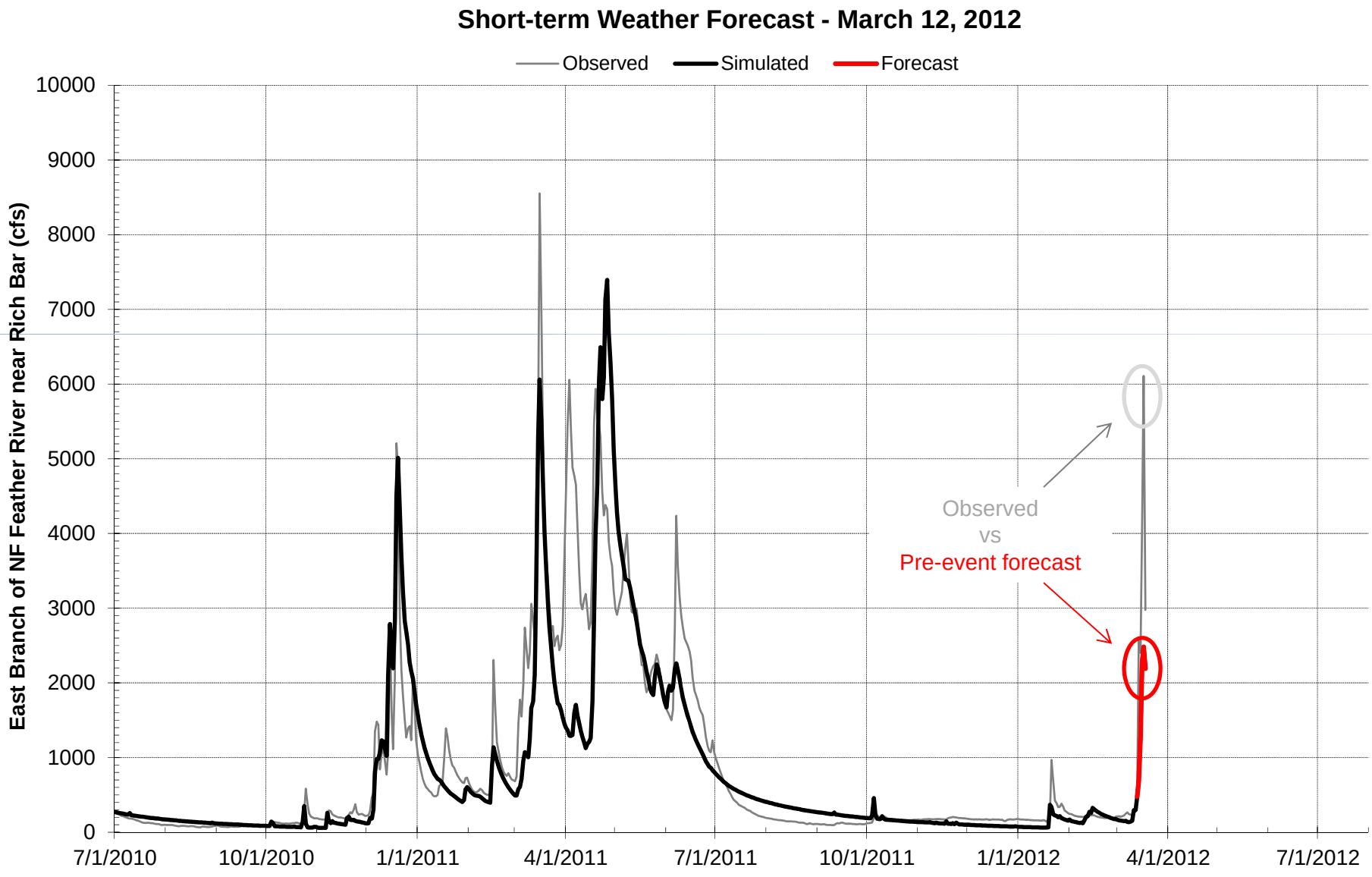
Parameter-elevation Regressions on Independent Slopes Model

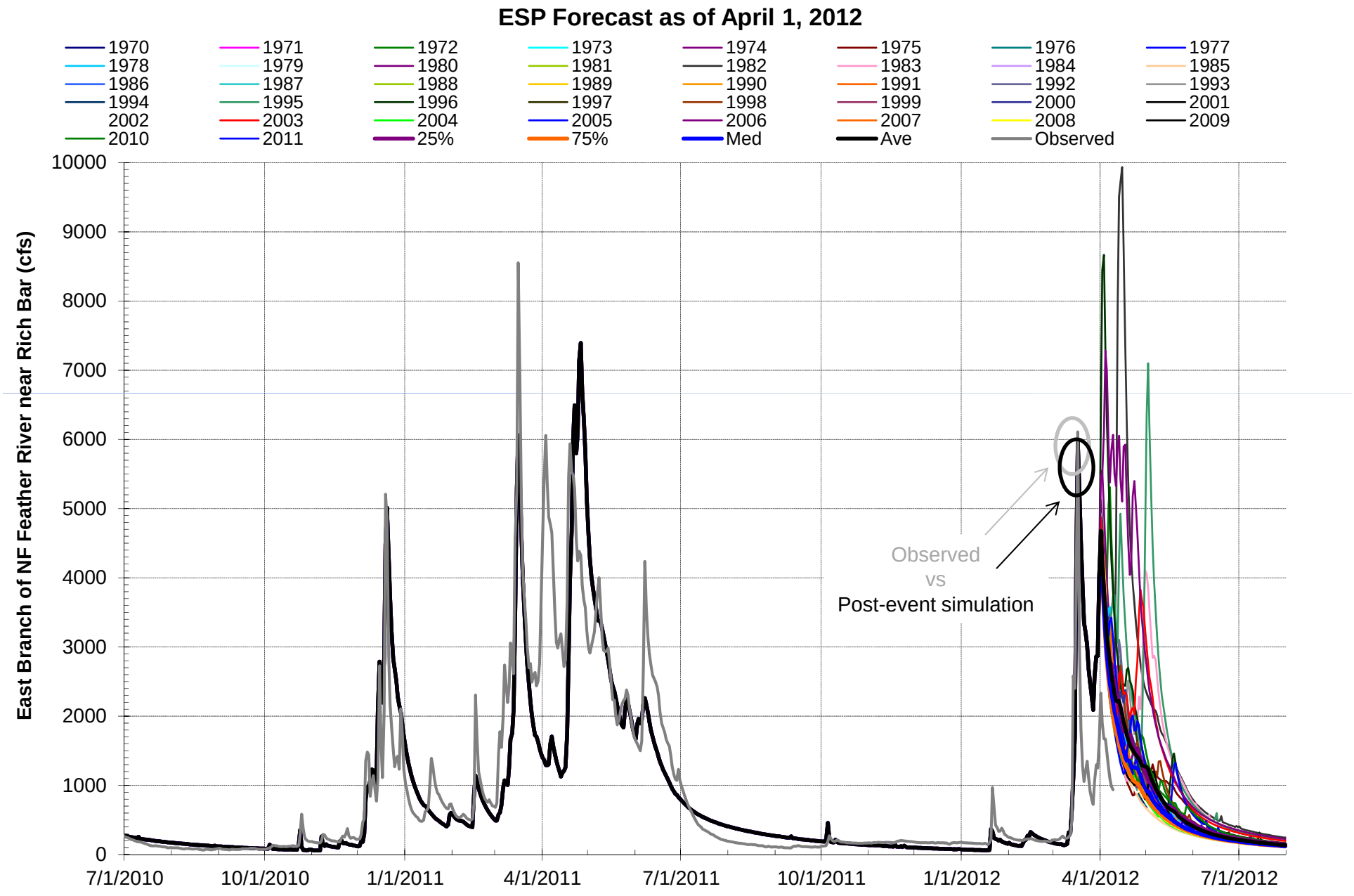
http://www.prism.oregonstate.edu/


Feather River Basin PRISM Surface - Normal Month Total (inches)
15
10
5
0
40.5
40.4
40.3
40.2
40.1
40
39.9
39.8
39.7
39.6
39.5
-121.4
-121.2
-121
-120.8
-120.6
-120.4
-120.2
12
10
8
6
4
2
0

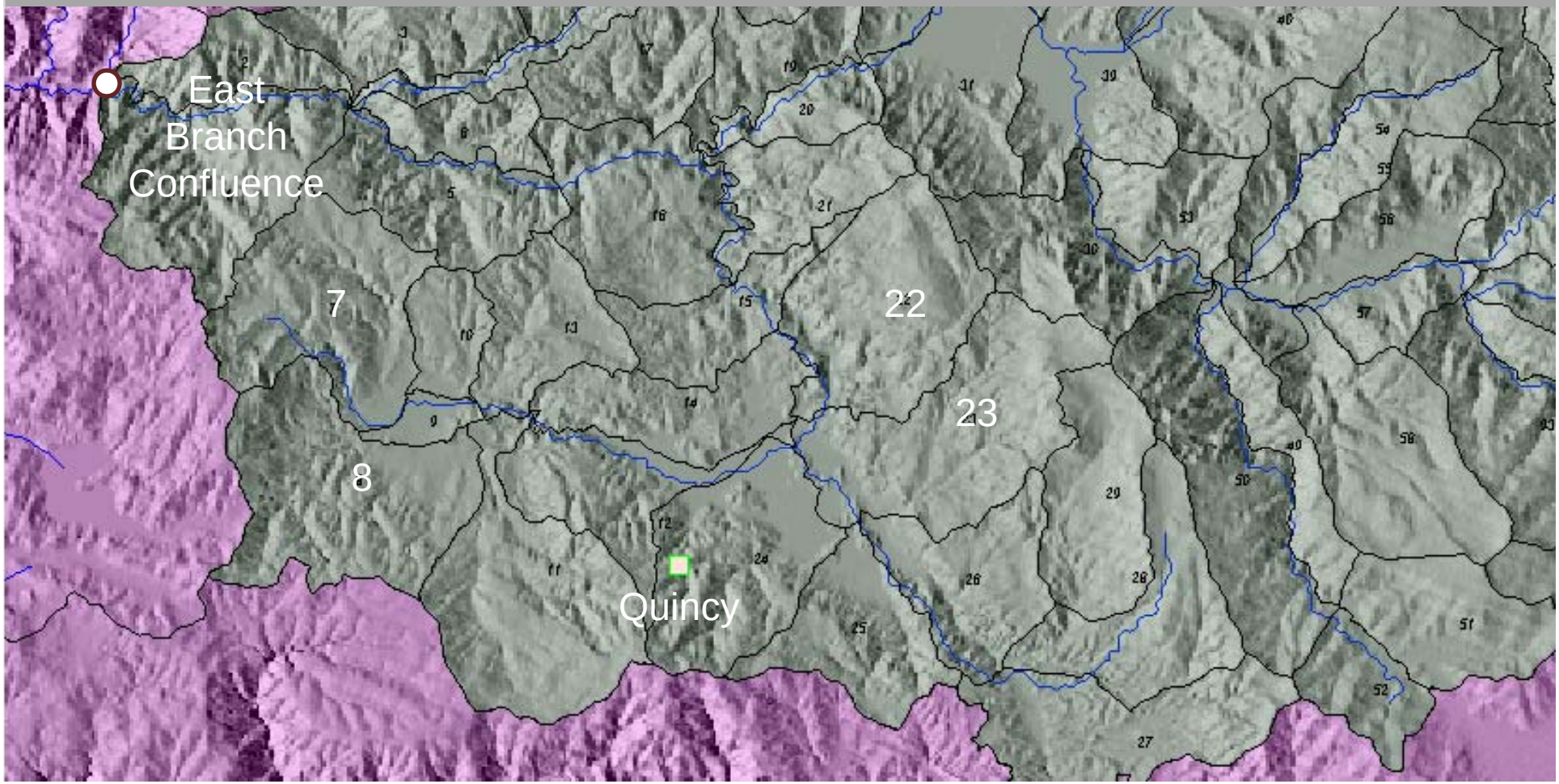

3/16/2012 Measured Precipitation - % of PRISM Norm
3000
2500
2000
1500
1000
500
0
40.5
40.4
40.3
40.2
40.1
40
39.9
39.8
39.7
39.6
39.5
-121.4
-121.2
-121
-120.8
-120.6
-120.4
-120.2
1800
1600
1400
1200
1000
800
600
400
200
0


3/16/2012 Calculated Precipitation (inches)
8
6
4
2
0
40.5
40.4
40.3
40.2
40.1
40
39.9
39.8
39.7
39.6
39.5
-121.4
-121.2
-121
-120.8
-120.6
-120.4
-120.2
7
6
5
4
3
2
1
0


Short-term Weather Forecast - March 12, 2012
Observed
Simulated
Forecast
East Branch of NF Feather River near Rich Bar (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
7/1/2010
10/1/2010
1/1/2011
4/1/2011
7/1/2011
10/1/2011
1/1/2012
4/1/2012
7/1/2012
Observed
vs
Pre-event forecast

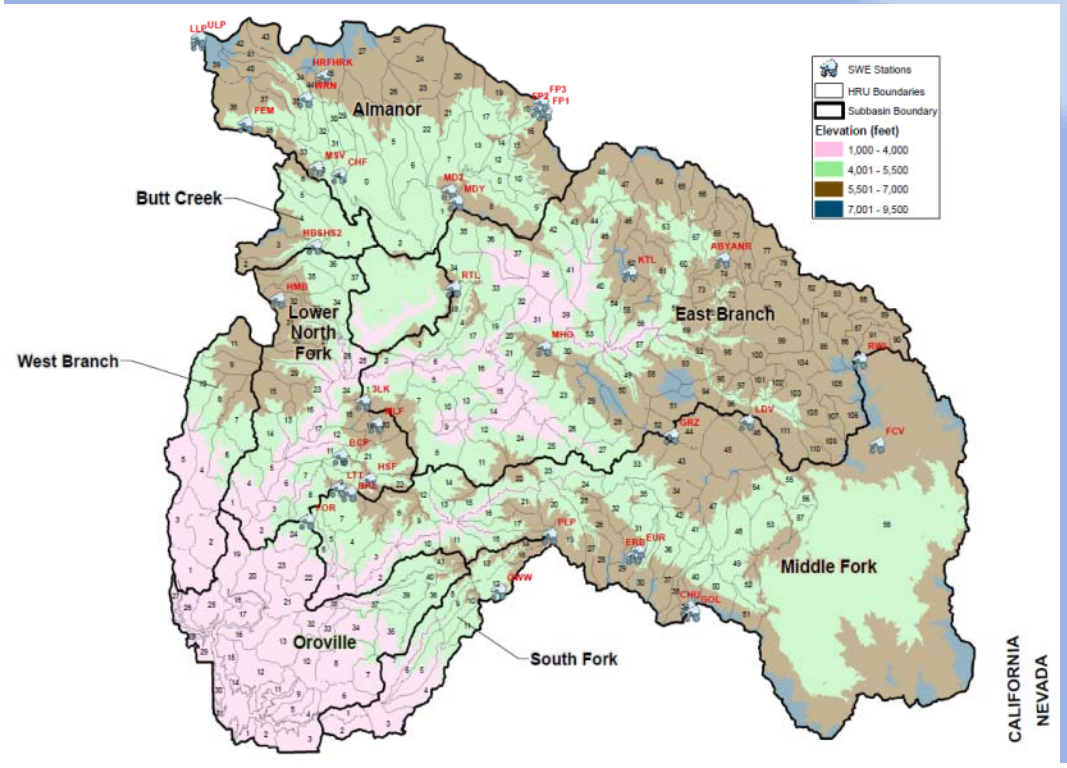

ESP Forecast as of April 1, 2012
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
25%
75%
Med
Ave
Observed
East Branch of NF Feather River near Rich Bar (cfs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
7/1/2010
10/1/2010
1/1/2011
4/1/2011
7/1/2011
10/1/2011
1/1/2012
4/1/2012
7/1/2012
Observed
vs
Post-event simulation

	Draped Actual Precipitation					Application of NWS Basin Average Preciptiation				
HRUs	7	8	22	23	Sub Ave	7	8	22	23	Sub Ave
12-Mar	0	0	0	0	0	0	0	0	0	0
13-Mar	2.5	2.6	1.7	1.5	0.8	1.3	1.3	1.3	1.3	1.3
14-Mar	2.7	2.8	2.7	2.7	1.7	0.6	0.6	0.6	0.6	0.6
15-Mar	1.1	1.2	0.9	0.9	0.5	1.0	1.0	1.0	1.0	1.0
16-Mar	3.3	3.3	3.5	3.3	2.2	1.5	1.5	1.5	1.5	1.5
17-Mar	0.8	0.9	1.0	1.0	0.7	0.7	0.7	0.7	0.7	0.7
18-Mar	0.3	0.3	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1
Total	10.7	11.1	10.1	9.7	**6.0**	5.2	5.2	5.2	5.2	**5.2**



PRMS Feather River PRMS Model
Improvement Status

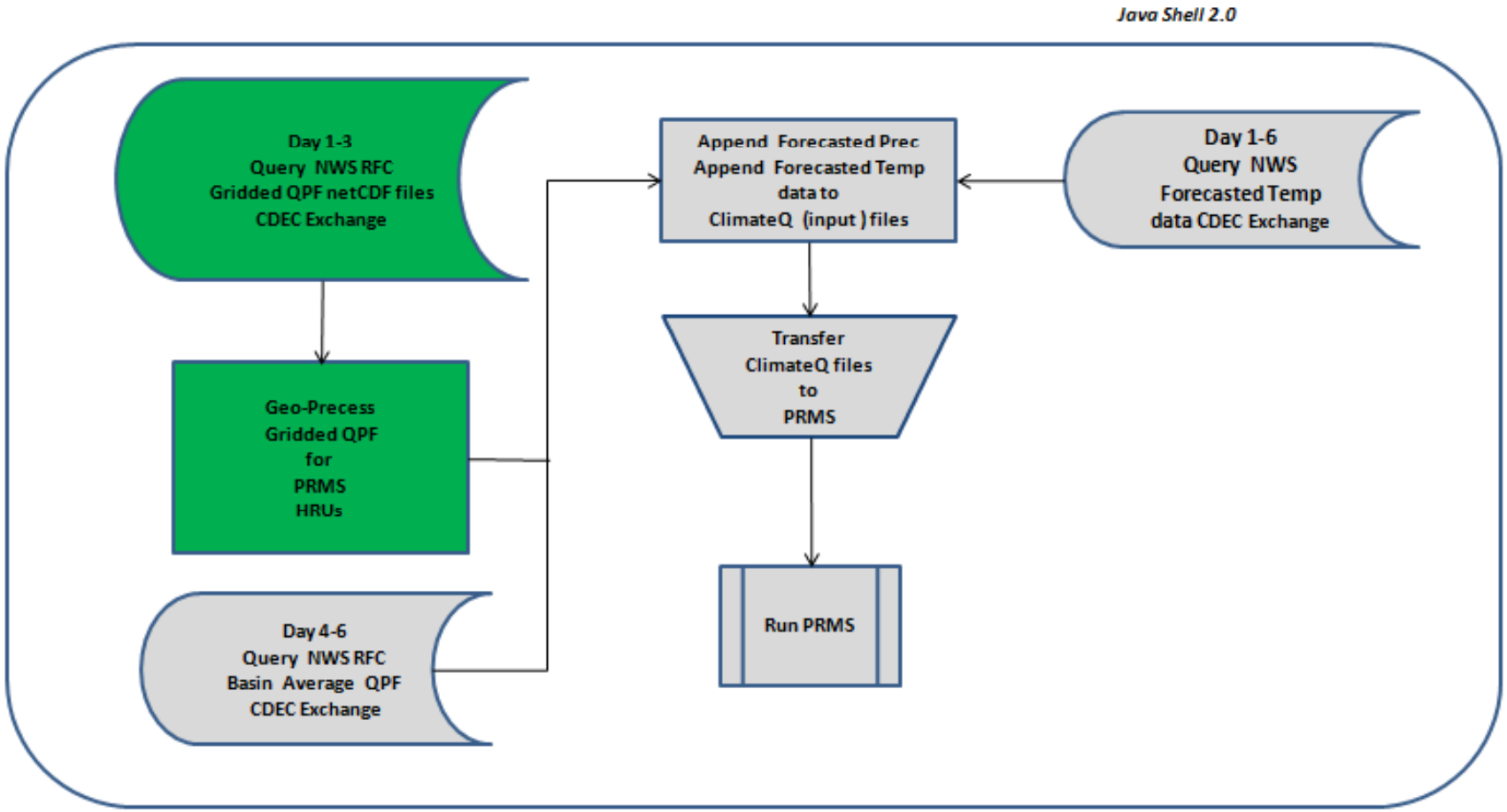
California Cooperative Meeting
November 8, 2012



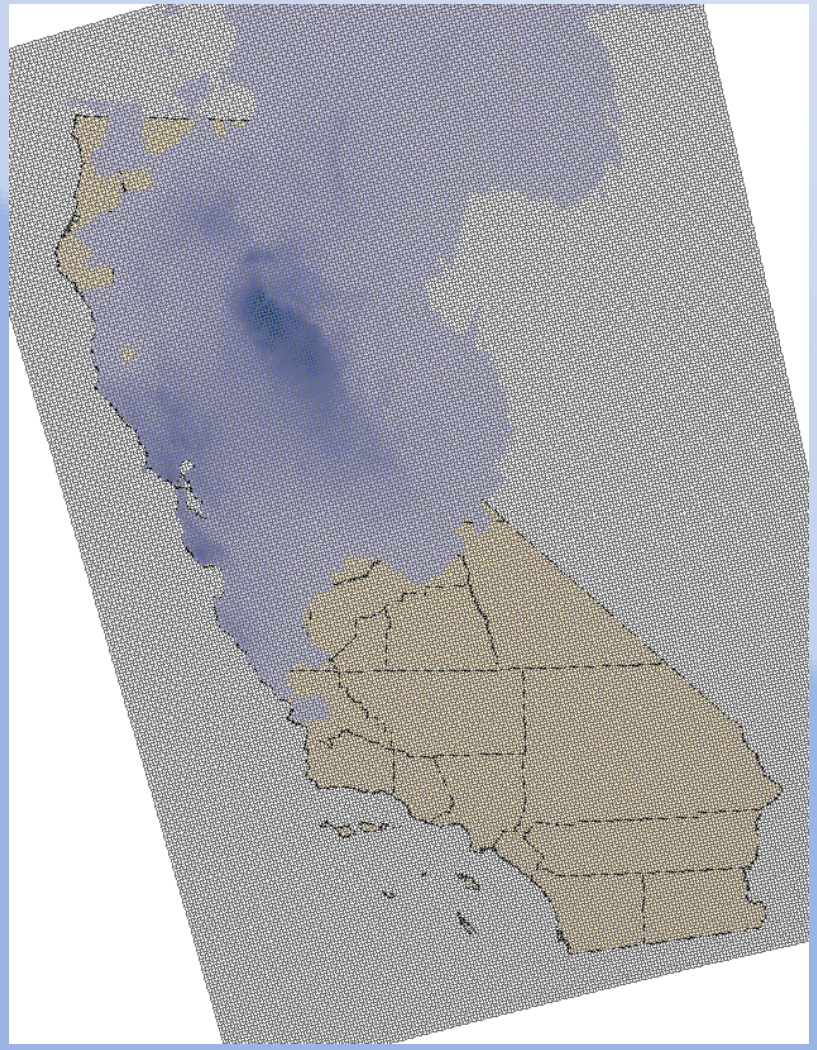
Feather Team:

John j. King
Kevin Richards
Khalida Fazel
Katherine Maher

Short-term Forecasting Improvements with Feather PRMS Model

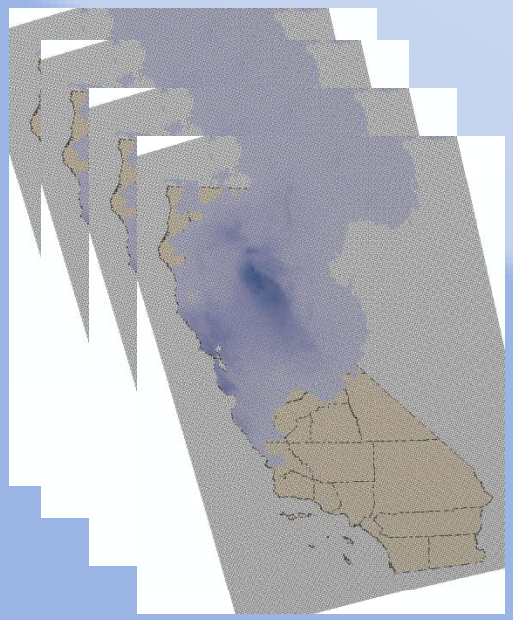


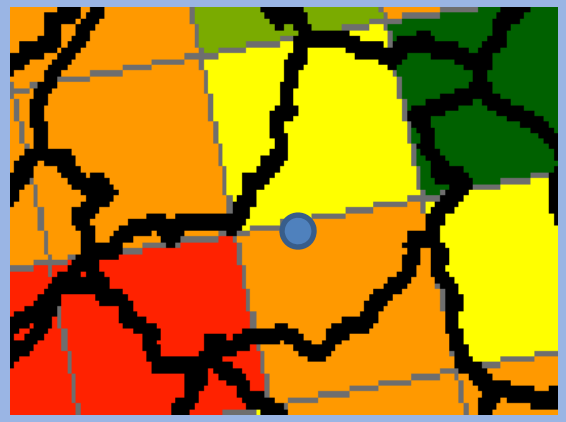
CNRFC Gridded QPF Data
Available :3 days, 6 hour segment



QPF 4.7km grid, CDF file format

Geo-processing Gridded QPF for PRMS HRUs





Process the CDF file to a ESRI shape file

Add the four 6 hour QPF grids for each day

Sample the gridded QPF for the centroid of the HRU

Append data to input file (Climate Q files)