Statistical Water Supply (SWS)

- Mathematical relationships, in the form of regression equations, between measurements of observed climate conditions (predictor variables) and streamflow for a specific period.

- Predictors used by the CBRFC (Min 30 yrs of record).
  - Total precipitation (for a month or period of months)
  - First of month snow water equivalent (SNOTEL data)
  - Monthly flow volume
  - Climate Signals: El Nino Southern Oscillation Index (SOI)

- Output is a seasonal volume (i.e. April-July, May-July, Jan-May).
  - It is really a conditional probability distribution, not a single value; the equation result is the 50% exceedance.
  - Exceedance levels (10%, 90%, etc.) can be calculated by using the standard error.
  - Forecast is for unregulated or "natural flow" (does not account for upstream diversions or reservoir storage) – (with the exception of a few sites).

Calculation Example: Flow observed at stream gage is adjusted for upstream diversions and/or reservoir storage. This procedure is done for all historical data and used in equation development, and forecast verification.

June 2010 calculation

RRBPC2 QCMPAZZ 06-2010	OBS	AVG	%AVG
RBPC2 QCMRZZZ +	1.66A	7.55	22%
BDVC2 QCMRZZZ +	12.36A	12.00	103%

	14.02A	18.35	76%

NAVC2 QCMPAZZ 06-2010	OBS	AVG	%AVG
NAVC2 QCMRZZZ +	4.64A	8.83	53%
NOSC2 QCMRZZZ +	14.61A	15.32	95%

	19.25A	24.74	78%

FRMN5 QCMPAZZ 06-2010	OBS	AVG	%AVG
FRMN5 QCMRZZZ +	117.89Z	289.82	41%
NVRN5 LSMRZZZ +	38.37A	63.79	60%
CHUN5 QCMRZZZ +	27.58A	30.05	92%
VCRC2 LSMRZZZ +	3.13A	16.45	19%
LEMC2 LSMRZZZ +	-3.21A	4.45	-72%
NIIN5 QCMRZZZ +	39.83A	26.75	149%
DPPC2 QCMRZZZ +	15.36A	0.00	-999

	238.96A	426.85	56%

Developing Equations:

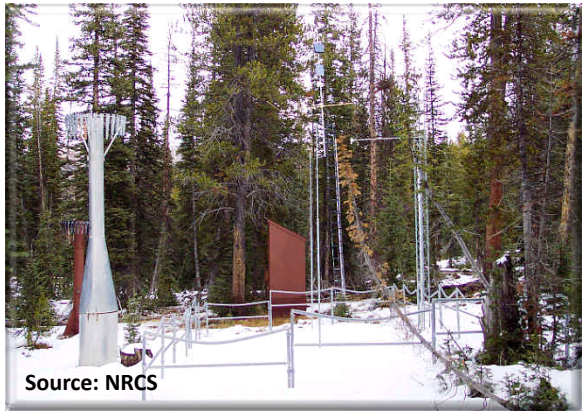
Predictor variables must make sense

Challenge when few observation sites exist within river basin

Challenge when measurement sites are relatively young

Fall & Spring precipitation is frequently used (why?)

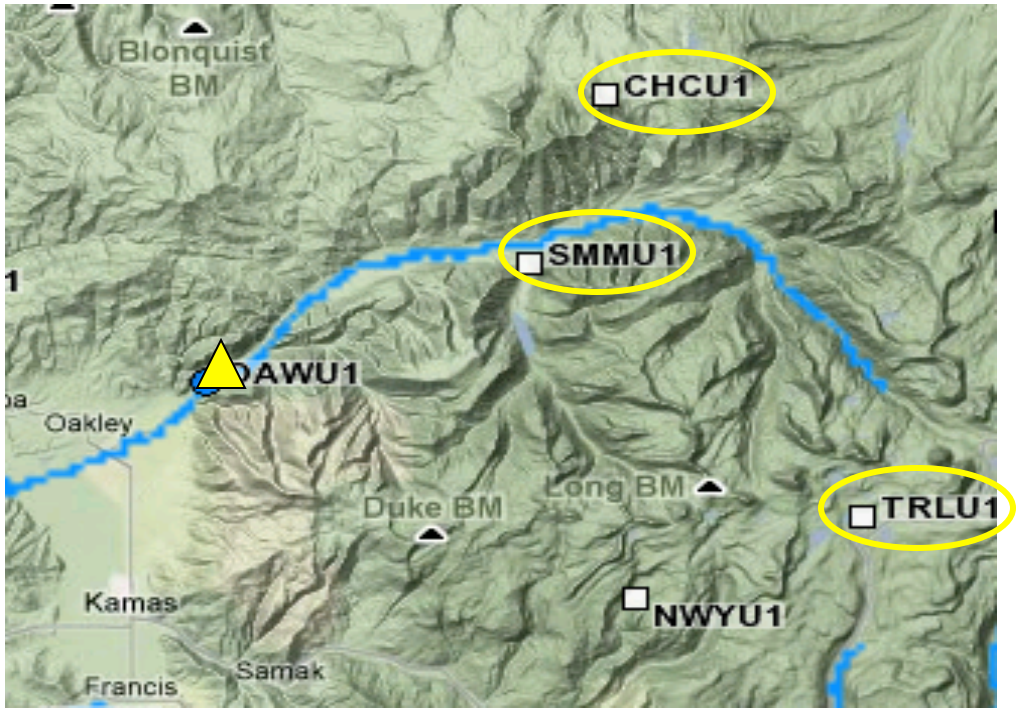
Trial Lake SNOTEL



Sample Equation for April 1:

April-July volume Weber @ Oakley =

+ 3.50 * Apr 1st Smith & Morehouse (SMMU1) Snow Water Equivalent
+ 1.66 * Apr 1st Trial Lake (TRLU1) Snow Water Equivalent
+ 2.40 * Apr 1st Chalk Creek #1 (CHCU1) Snow Water Equivalent
- 28.27

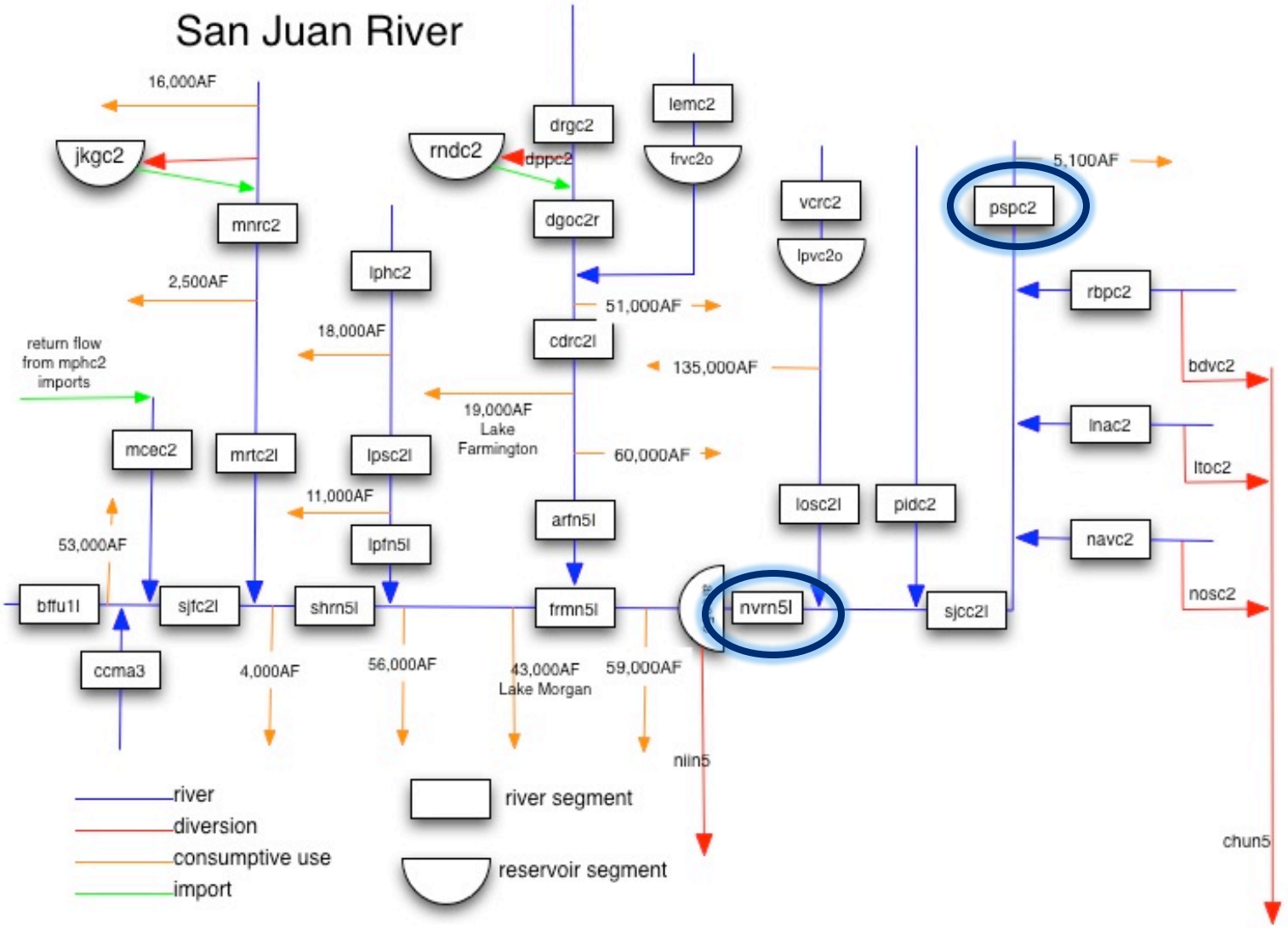


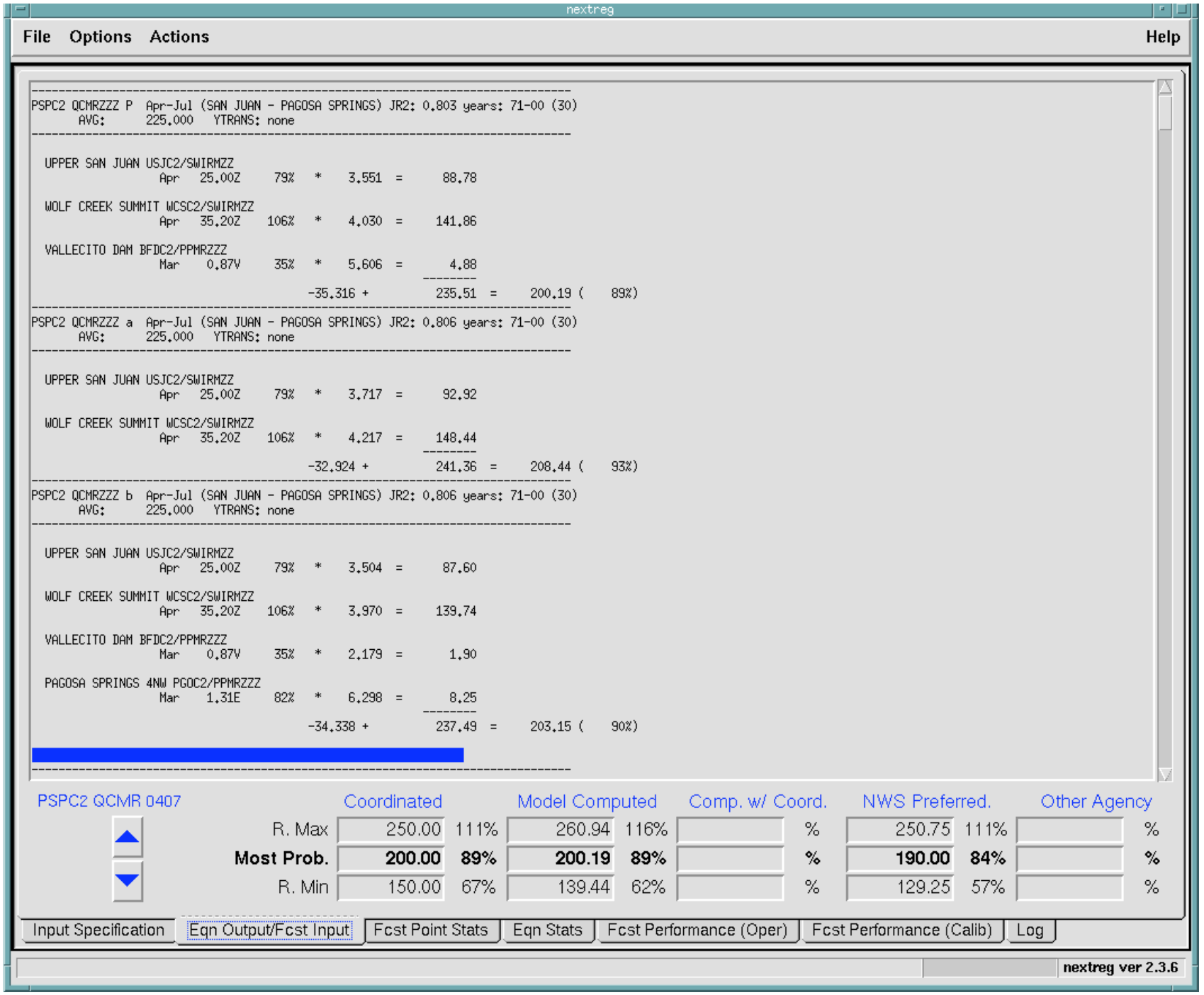
Statistical Water Supply (SWS)

- Two types of forecast equations:
  - Headwater Equations: Previous example using current climate measures for predictor variables (typically top of basin sites)
  - Routed Equations: For downstream points the regression equation'routes' the upstream volume forecast. A relationship is built between historical observed runoff between upstream and downstream sites. The upstream forecast volume is then plugged into this relationship resulting in a forecast for the downstream site.
  - Routed Forecast Equation Example: Lake Powell
  - Good correlation with historical upstream observed flows:
    - Green at Green River + Colorado nr Cisco + San Juan nr Bluff
    - r^2 = .994 for historical observed data between Powell and these sites
    - Forecast at these upstream sites are plugged into this relationship

SWS Software Demonstration:

PSPC2: San Juan @ Pagosa Springs – Headwater Equation
NVRN5: San Juan, Navajo Reservoir Inflow – Routed Equation




nextreg
File Options Actions Help
PSPC2 QCMRZZZ P Apr-Jul (SAN JUAN - PAGOSA SPRINGS) JR2: 0.803 years: 71-00 (30)
AVG: 225.000 YTRANS: none
UPPER SAN JUAN USJC2/SWIRMZZ
Apr 25.00Z 79% * 3.551 = 88.78
WOLF CREEK SUMMIT WCSC2/SWIRMZZ
Apr 35.20Z 106% * 4.030 = 141.86
VALLECITO DAM BFDC2/PPMRZZZ
Mar 0.87V 35% * 5.606 = 4.88
-35.316 + 235.51 = 200.19 (89%)
PSPC2 QCMRZZZ a Apr-Jul (SAN JUAN - PAGOSA SPRINGS) JR2: 0.806 years: 71-00 (30)
AVG: 225.000 YTRANS: none
UPPER SAN JUAN USJC2/SWIRMZZ
Apr 25.00Z 79% * 3.717 = 92.92
WOLF CREEK SUMMIT WCSC2/SWIRMZZ
Apr 35.20Z 106% * 4.217 = 148.44
-32.924 + 241.36 = 208.44 (93%)
PSPC2 QCMRZZZ b Apr-Jul (SAN JUAN - PAGOSA SPRINGS) JR2: 0.806 years: 71-00 (30)
AVG: 225.000 YTRANS: none
UPPER SAN JUAN USJC2/SWIRMZZ
Apr 25.00Z 79% * 3.504 = 87.60
WOLF CREEK SUMMIT WCSC2/SWIRMZZ
Apr 35.20Z 106% * 3.970 = 139.74
VALLECITO DAM BFDC2/PPMRZZZ
Mar 0.87V 35% * 2.179 = 1.90
PAGOSA SPRINGS 4NW PGOC2/PPMRZZZ
Mar 1.31E 82% * 6.298 = 8.25
-34.338 + 237.49 = 203.15 (90%)
PSPC2 QCMR 0407
Coordinated
Model Computed
Comp. w/ Coord.
NWS Preferred.
Other Agency
R. Max 250.00 111% 260.94 116% % 250.75 111% %
Most Prob. 200.00 89% 200.19 89% % 190.00 84% %
R. Min 150.00 67% 139.44 62% % 129.25 57% %
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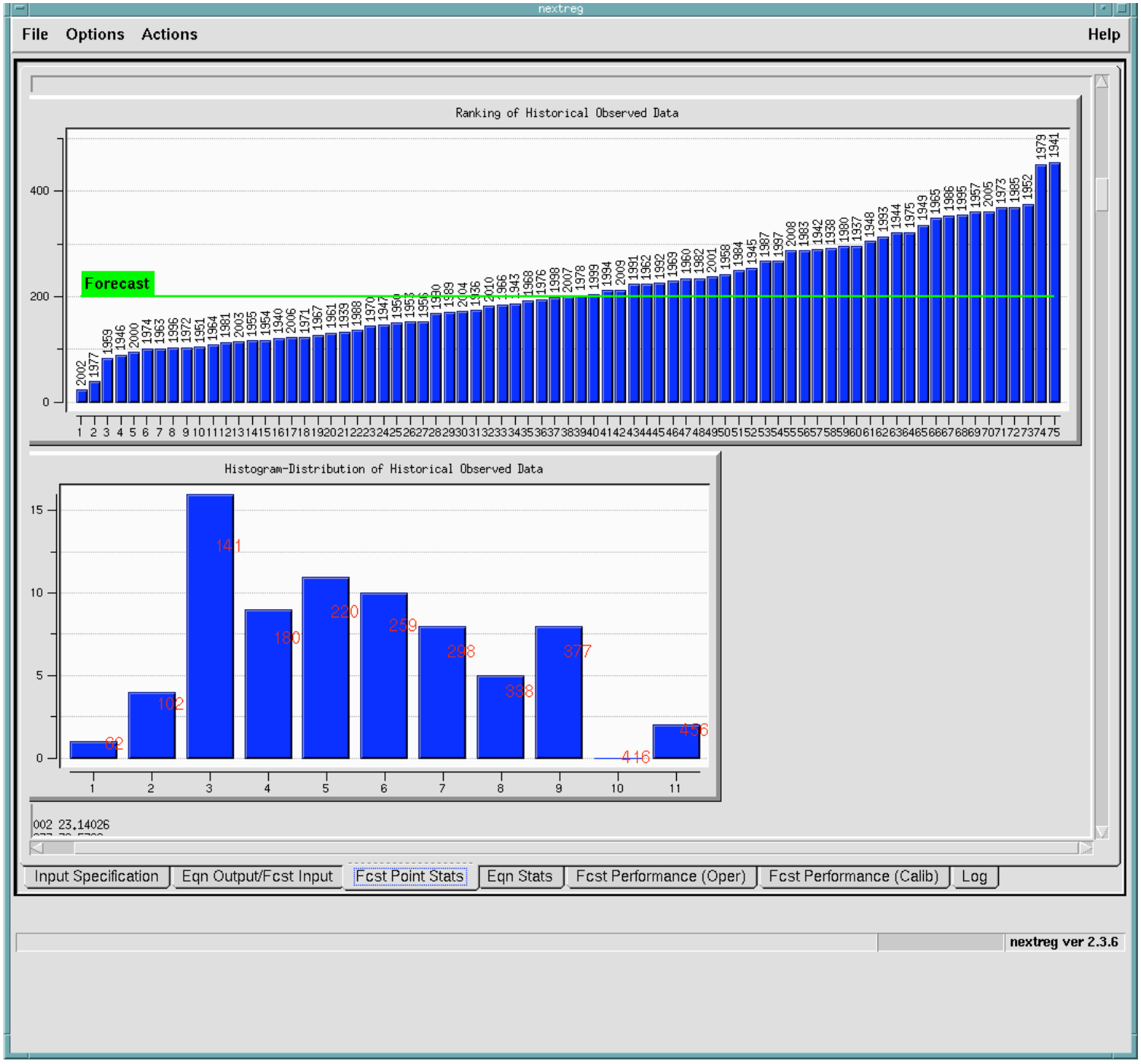
Eqn Output/Fcst Input
Fcst Point Stats
Eqn Stats
Fcst Performance (Oper)
Fcst Performance (Calib)
Log
nextreg ver 2.3.6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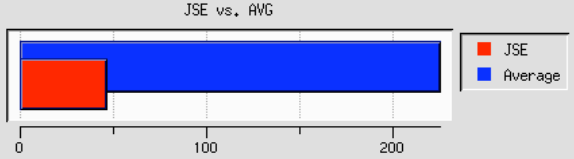
File
Options
Actions
Help
Ranking of Historical Observed Data
Forecast
Histogram-Distribution of Historical Observed Data
141
180
220
259
298
338
377
416
002 23.14026
Input Specification
Eqn Output/Fcst Input
Fcst Point Stats
Eqn Stats
Fcst Performance (Oper)
Fcst Performance (Calib)
Log
nextreg ver 2.3.6

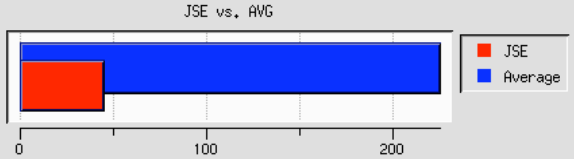
nextreg

File Options Actions Help

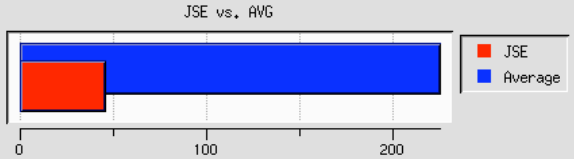
PSPC2_QCMRZZZ_0710 P
Calibration JSE: 46.23
JR2: 0.80
R2: 0.83
n: 30
per: 71-00



PSPC2_QCMRZZZ_0710 a
Calibration JSE: 45.08
JR2: 0.81
R2: 0.83
n: 30
per: 71-00

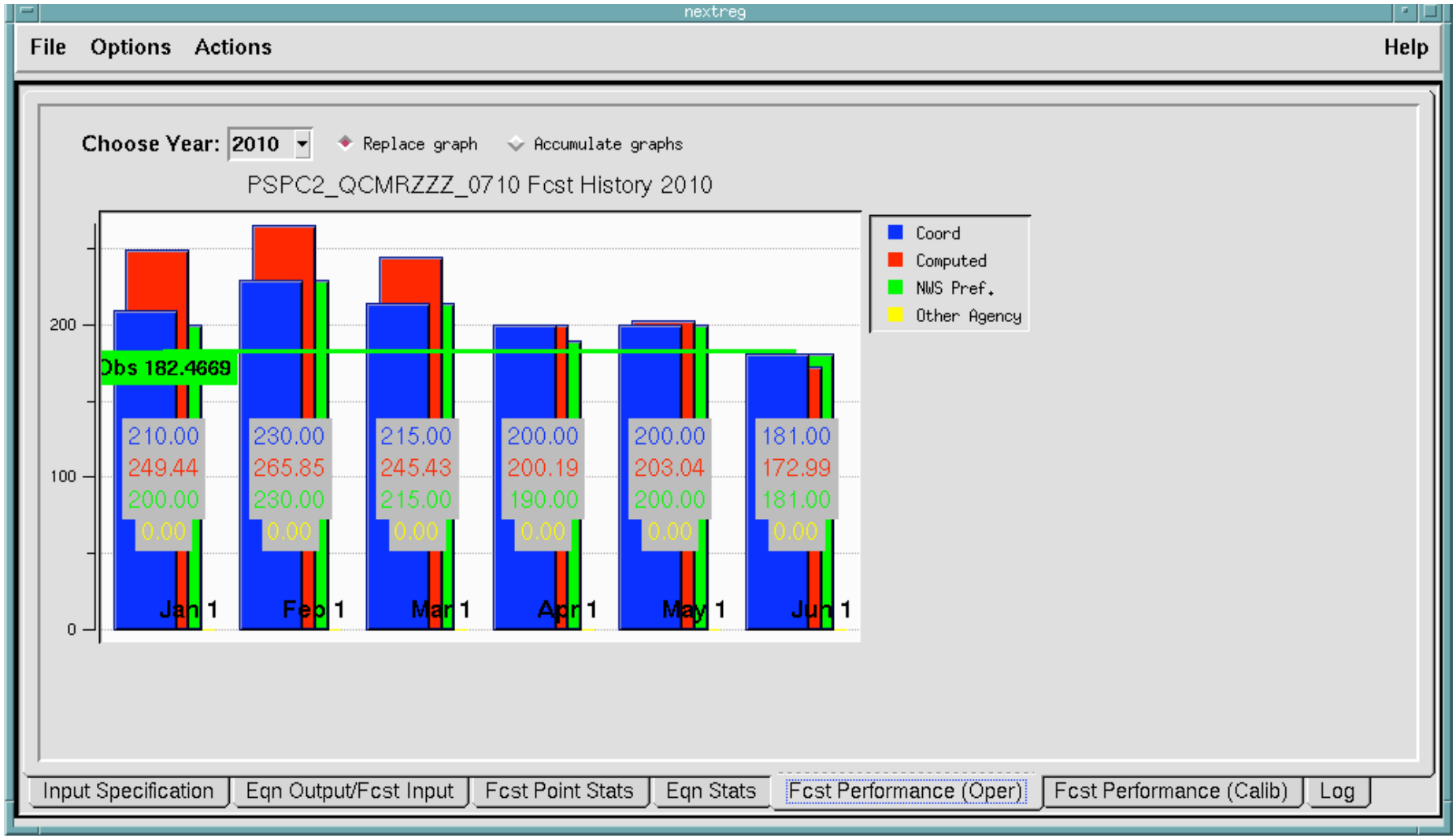


PSPC2_QCMRZZZ_0710 b
Calibration JSE: 45.87
JR2: 0.81
R2: 0.84
n: 30
per: 71-00



Input Specification | Eqn Output/Fcst Input | Fcst Point Stats | Eqn Stats | Fcst Performance (Oper) | Fcst Performance (Calib) | Log

nextreg ver 2.3.6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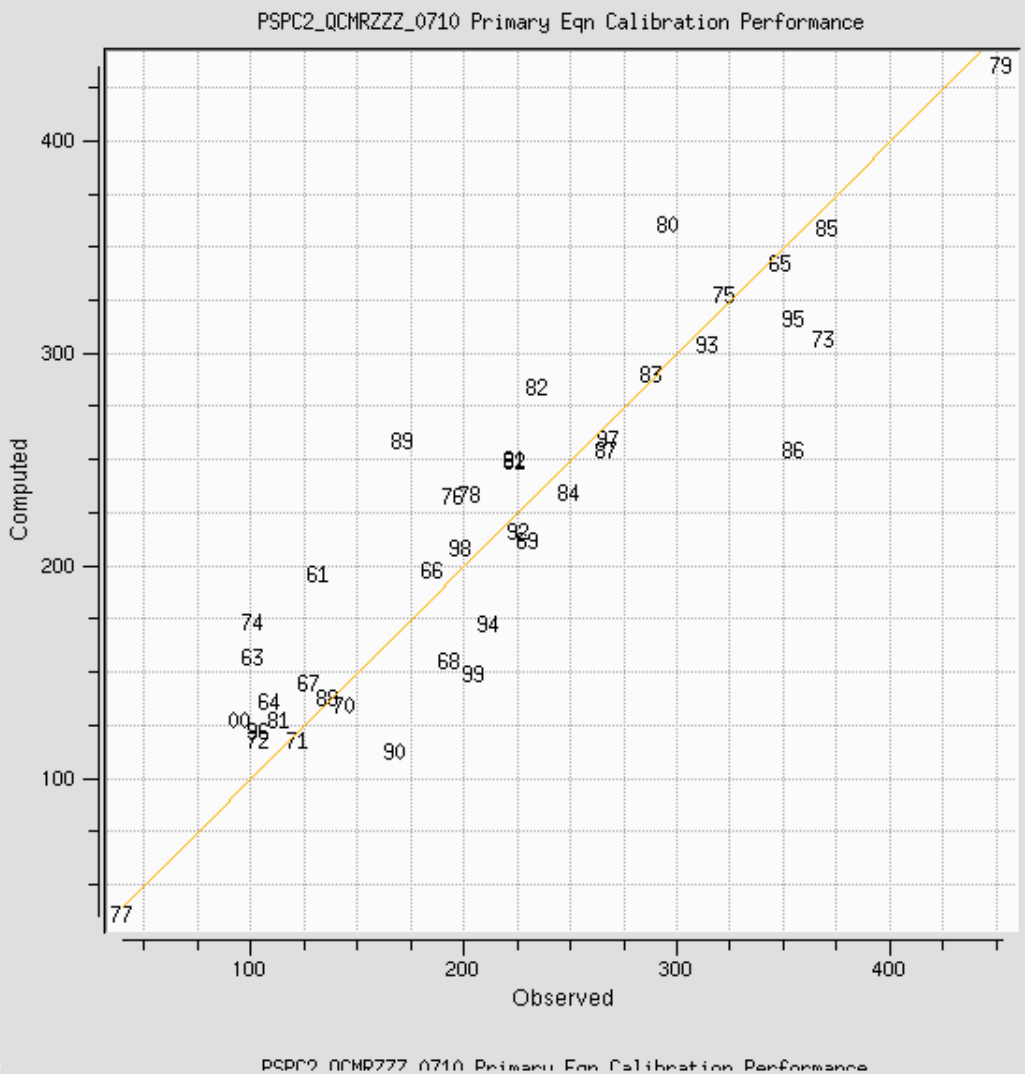
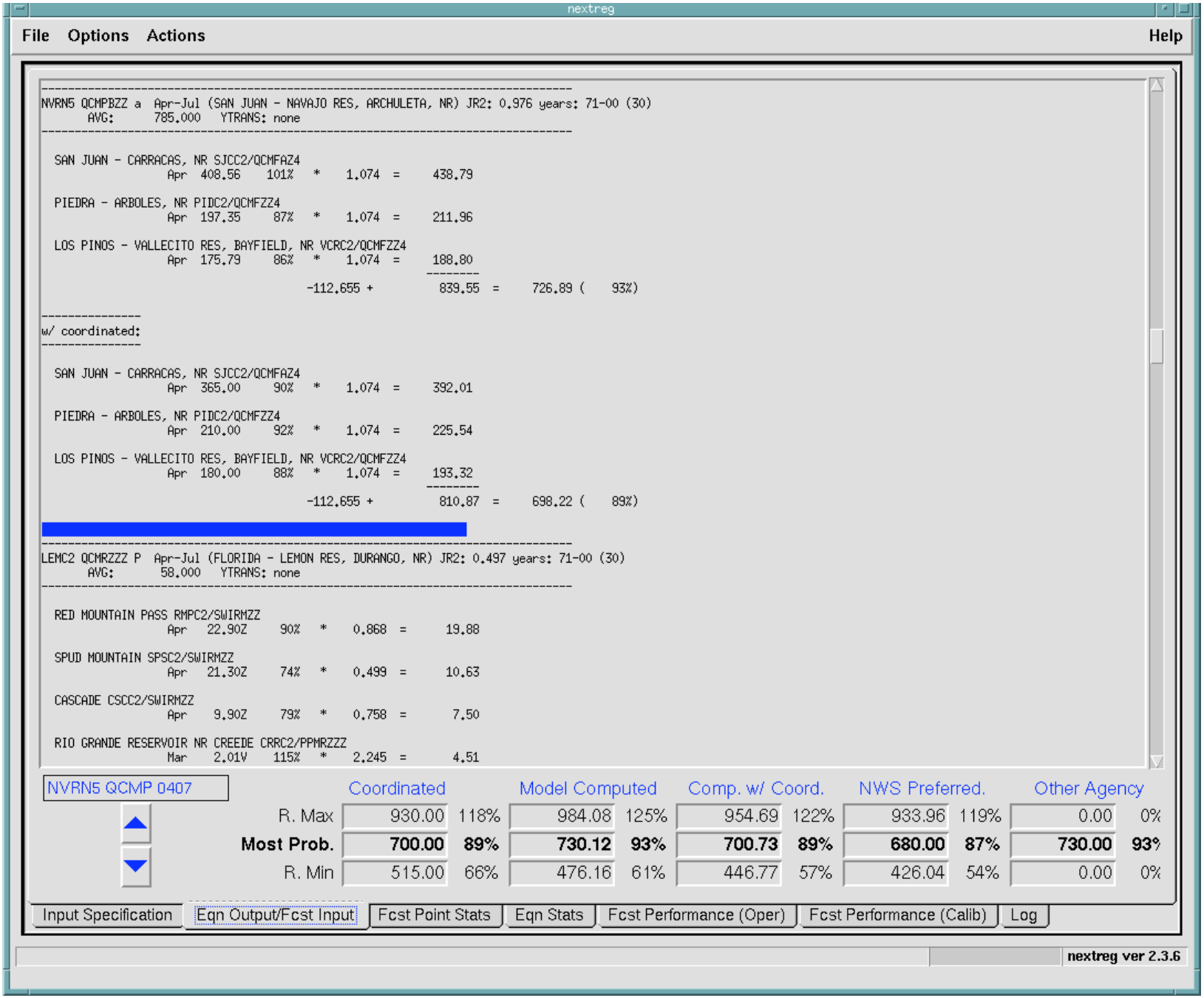
File
Options
Actions
Help
Choose Year:
2010
Replace graph
Accumulate graphs
PSPC2_QCMRZZZ_0710 Fcst History 2010
Coord
Computed
NWS Pref.
Other Agency
200
100
0
Obs 182.4669
210.00
249.44
200.00
0.00
230.00
265.85
230.00
0.00
215.00
245.43
215.00
0.00
200.00
200.19
190.00
0.00
200.00
203.04
200.00
0.00
181.00
172.99
181.00
0.00
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Input Specification
Eqn Output/Fcst Input
Fcst Point Stats
Eqn Stats
Fcst Performance (Oper)
Fcst Performance (Calib)
Log

nextreg

File Options Actions Help



Input Specification | Eqn Output/Fcst Input | Fcst Point Stats | Eqn Stats | Fcst Performance (Oper) | Fcst Performance (Calib) | Log


nextreg
File
Options
Actions
Help
NVRN5 QCMPBZZ a Apr-Jul (SAN JUAN - NAVAJO RES, ARCHULETA, NR) JR2: 0.976 years: 71-00 (30)
AVG: 785.000 YTRANS: none
SAN JUAN - CARRACAS, NR SJCC2/QCMFAZ4
Apr 408.56 101% * 1.074 = 438.79
PIEDRA - ARBOLES, NR PIDC2/QCMFZZ4
Apr 197.35 87% * 1.074 = 211.96
LOS PINOS - VALLECITO RES, BAYFIELD, NR VCRC2/QCMFZZ4
Apr 175.79 86% * 1.074 = 188.80
-112.655 + 839.55 = 726.89 (93%)
w/ coordinated:
SAN JUAN - CARRACAS, NR SJCC2/QCMFAZ4
Apr 365.00 90% * 1.074 = 392.01
PIEDRA - ARBOLES, NR PIDC2/QCMFZZ4
Apr 210.00 92% * 1.074 = 225.54
LOS PINOS - VALLECITO RES, BAYFIELD, NR VCRC2/QCMFZZ4
Apr 180.00 88% * 1.074 = 193.32
-112.655 + 810.87 = 698.22 (89%)
LEMC2 QCMRZZZ P Apr-Jul (FLORIDA - LEMON RES, DURANGO, NR) JR2: 0.497 years: 71-00 (30)
AVG: 58.000 YTRANS: none
RED MOUNTAIN PASS RMPC2/SWIRMZZ
Apr 22.90Z 90% * 0.868 = 19.88
SPUD MOUNTAIN SPSC2/SWIRMZZ
Apr 21.30Z 74% * 0.499 = 10.63
CASCADE CSCC2/SWIRMZZ
Apr 9.90Z 79% * 0.758 = 7.50
RIO GRANDE RESERVOIR NR CREEDE CRRC2/PPMRZZZ
Mar 2.01V 115% * 2.245 = 4.51
NVRN5 QCMP 0407
Coordinated
Model Computed
Comp. w/ Coord.
NWS Preferred.
Other Agency
R. Max 930.00 118% 984.08 125% 954.69 122% 933.96 119% 0.00 0%
Most Prob. 700.00 89% 730.12 93% 700.73 89% 680.00 87% 730.00 93%
R. Min 515.00 66% 476.16 61% 446.77 57% 426.04 54% 0.00 0%
Input Specification
Eqn Output/Fcst Input
Fcst Point Stats
Eqn Stats
Fcst Performance (Oper)
Fcst Performance (Calib)
Log
nextreg ver 2.3.6

SWS vs. ESP

- Easy to calibrate, maintain and run, but requires sufficient historical record.
- Does not represent physical processes associated with snow melt, runoff, etc.
- Developed only for seasonal volumes (pre-defined periods in equations).
- Equations can only be run at specific times (i.e. first of month) for a specific forecast period.
- Lacks representation of soil moisture

- Requires extensive calibration, maintenance, & infrastructure. Stringent data requirements.
- Physical processes represented mathematically.
- Can compute many hydrologic variables over any period.
- Can be run at any time for any period.
- Keeps track of soil moisture.