Comparison of CAT and CVP IRP Scenarios

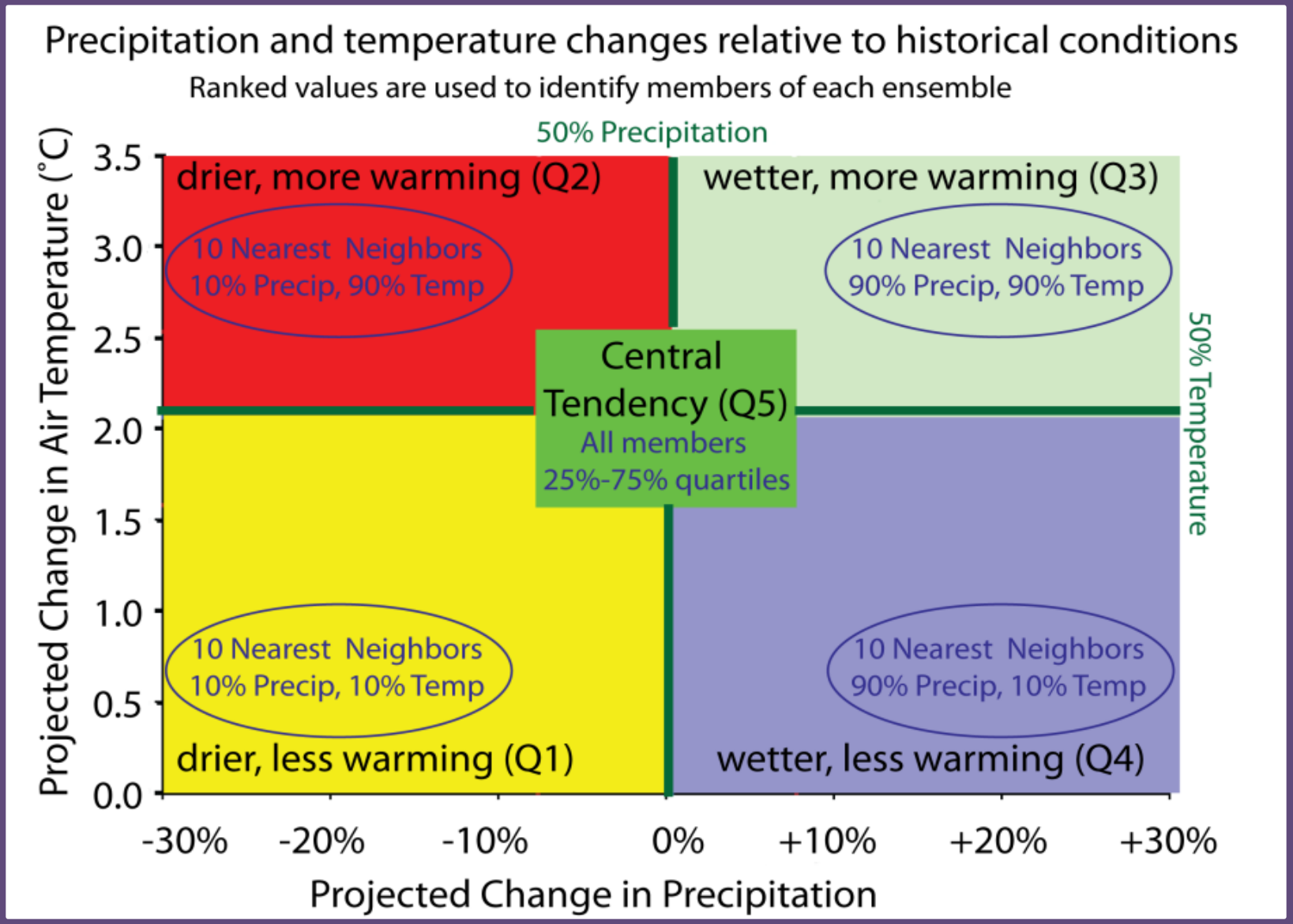
CCTAG Meeting May 11, 2012

But before we go there…

Let’s review the BDCP Method we talked about last month

The BDCP Approach

- 5 Ensemble scenarios drawn from the entire suite of 112 downscaled projections using BCSD
- Climate statistics derived from each ensemble (Q1-Q5) for two 30-year time slices 2010-2040 and 2045-2075
- Climate statistics for each period mapped onto the observed historical record


Precipitation and temperature changes relative to historical conditions
Ranked values are used to identify members of each ensemble
50% Precipitation
50% Temperature
drier, more warming (Q2)
10 Nearest Neighbors
10% Precip, 90% Temp
wetter, more warming (Q3)
10 Nearest Neighbors
90% Precip, 90% Temp
Central Tendency (Q5)
All members
25%-75% quartiles
10 Nearest Neighbors
10% Precip, 10% Temp
drier, less warming (Q1)
10 Nearest Neighbors
90% Precip, 10% Temp
wetter, less warming (Q4)
Projected Change in Air Temperature (°C)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-30%
-20%
-10%
0%
+10%
+20%
+30%
Projected Change in Precipitation

BDCP vs. CAT vs. CVP-IRP

- **BDCP – Static climate, the climate does not evolve over time.** Interannual variability, interdecadal variability, and long-term trends come only from the historical record

- **CAT –** 12 individual model driven projections with no direct link to historical record. **Climate evolves through simulation.**

- **CVP-IRP –** Same 5 ensembles used by BDCP but climate statistics are calculated about every 15 years and interpolated to define the unique climate statistics for every year. **Climate evolves through simulation.**

Four Locations

- Red Bluff

(northern-valley)

- Oroville

(northern-mountain)

- Fresno

(southern-valley)

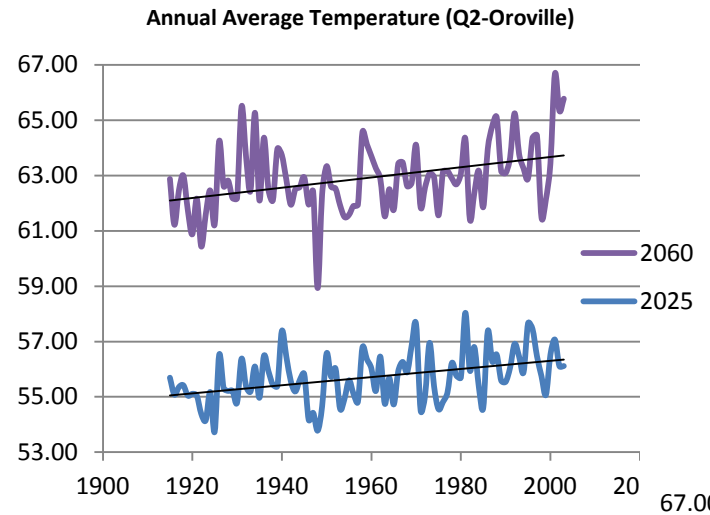
- Millerton

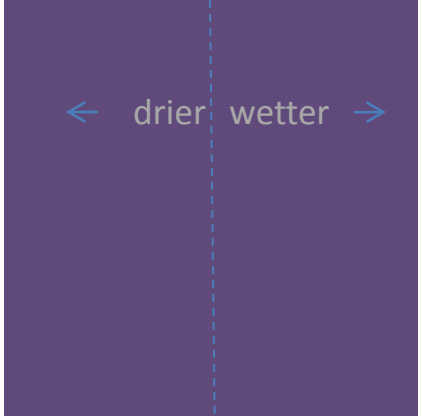
(northern-mountain)

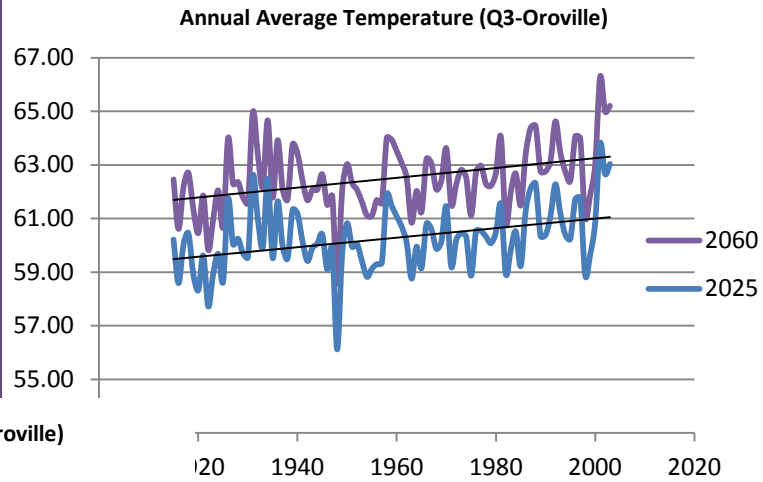
BDCP

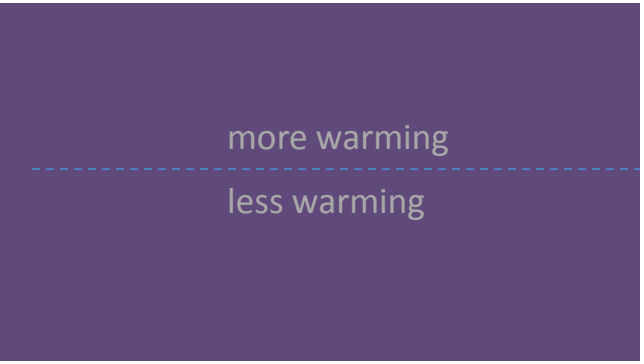
Oroville

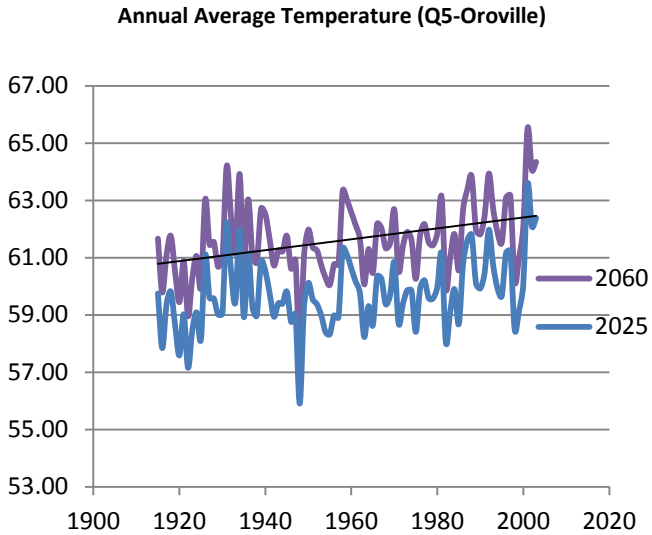
Temperature

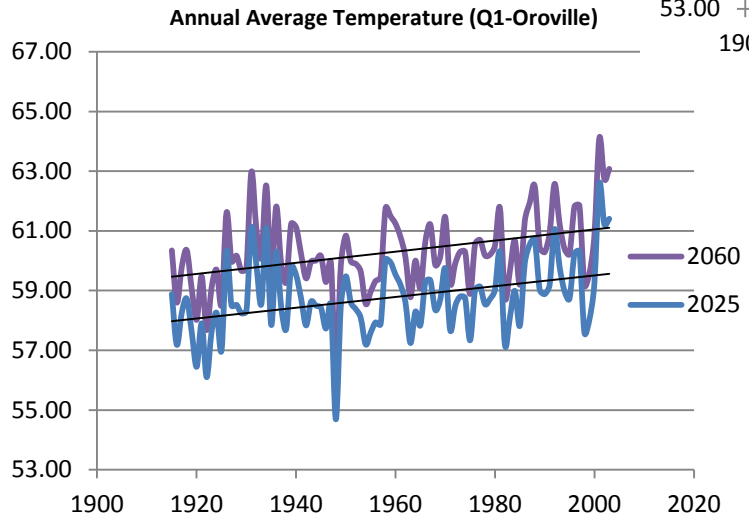

Annual Average Temperature (Q2-Oroville)
67.00
65.00
63.00
61.00
59.00
57.00
55.00
53.00
1900
1920
1940
1960
1980
2000
20
2060
2025

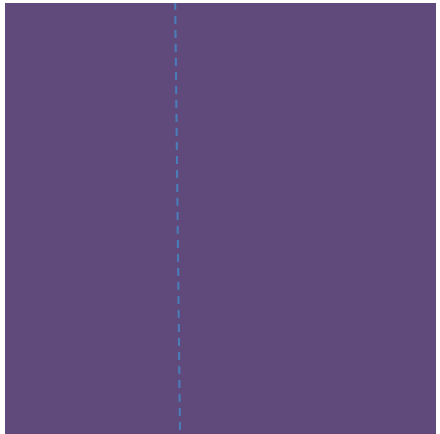

drier
wetter

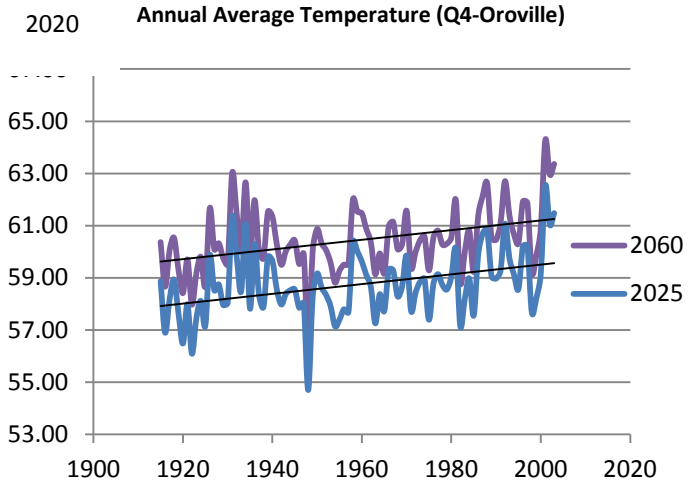

Annual Average Temperature (Q3-Oroville)
67.00
65.00
63.00
61.00
59.00
57.00
55.00
20
1940
1960
1980
2000
2020
2060
2025


more warming
less warming


Annual Average Temperature (Q5-Oroville)
67.00
65.00
63.00
61.00
59.00
57.00
55.00
53.00
1900
1920
1940
1960
1980
2000
2020
2060
2025


Annual Average Temperature (Q1-Oroville)
67.00
65.00
63.00
61.00
59.00
57.00
55.00
53.00
1900
1920
1940
1960
1980
2000
2020
2060
2025

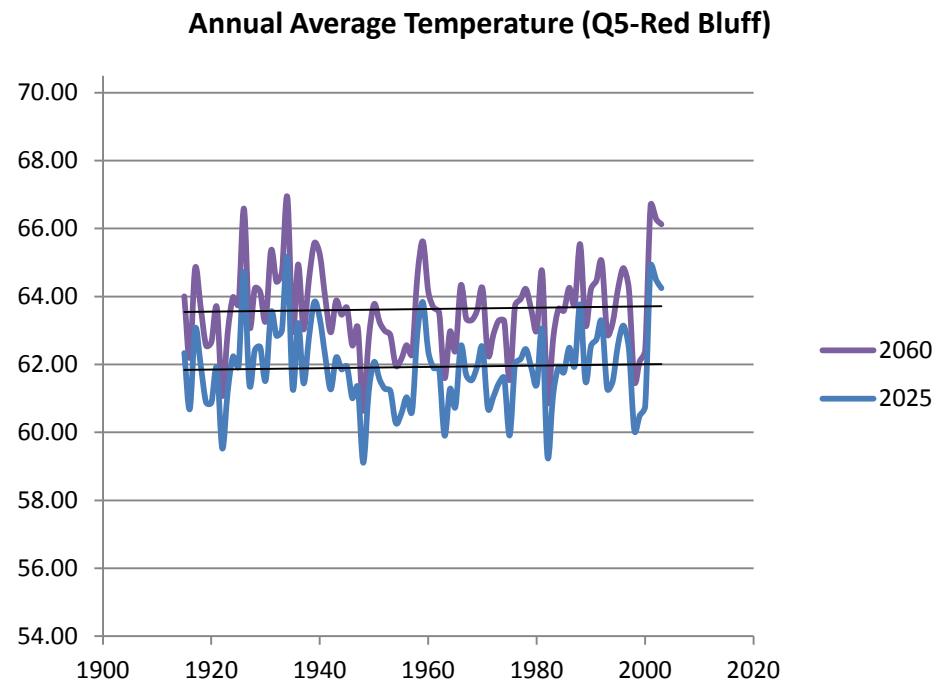


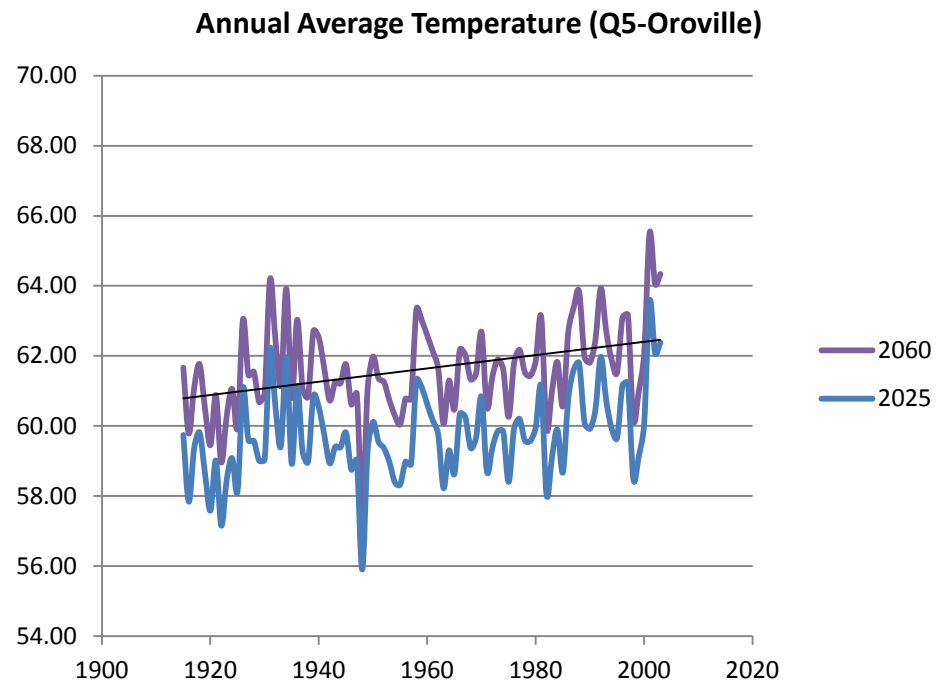

Annual Average Temperature (Q4-Oroville)
65.00
63.00
61.00
59.00
57.00
55.00
53.00
1900
1920
1940
1960
1980
2000
2020
2060
2025

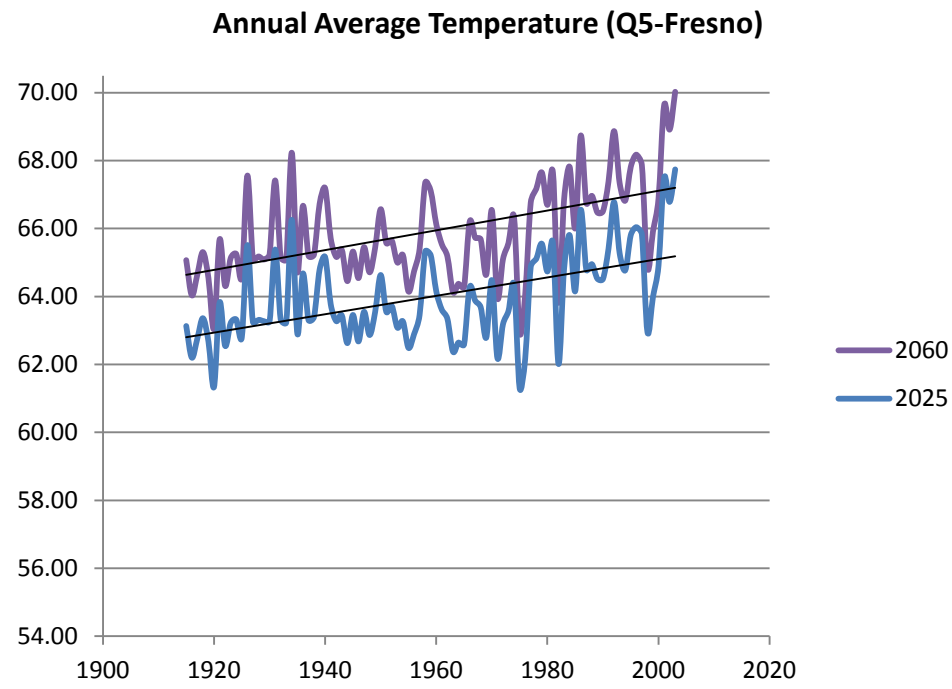
BDCP

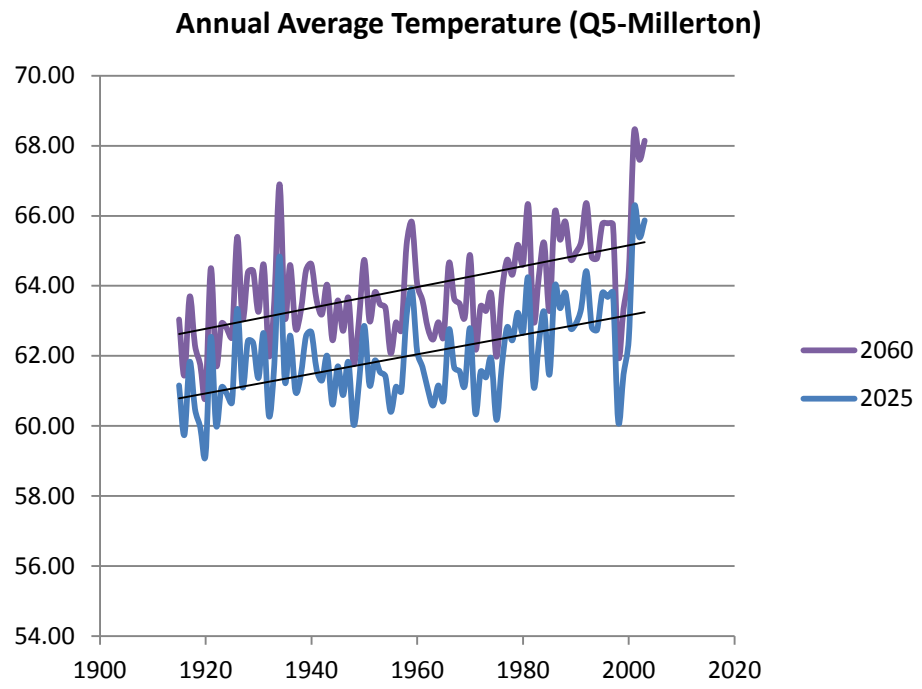
All 4 Locations

Temperature


Annual Average Temperature (Q5-Red Bluff)
70.00
68.00
66.00
64.00
62.00
60.00
58.00
56.00
54.00
1900
1920
1940
1960
1980
2000
2020
2060
2025


Annual Average Temperature (Q5-Oroville)
70.00
68.00
66.00
64.00
62.00
60.00
58.00
56.00
54.00
1900
1920
1940
1960
1980
2000
2020
2060
2025

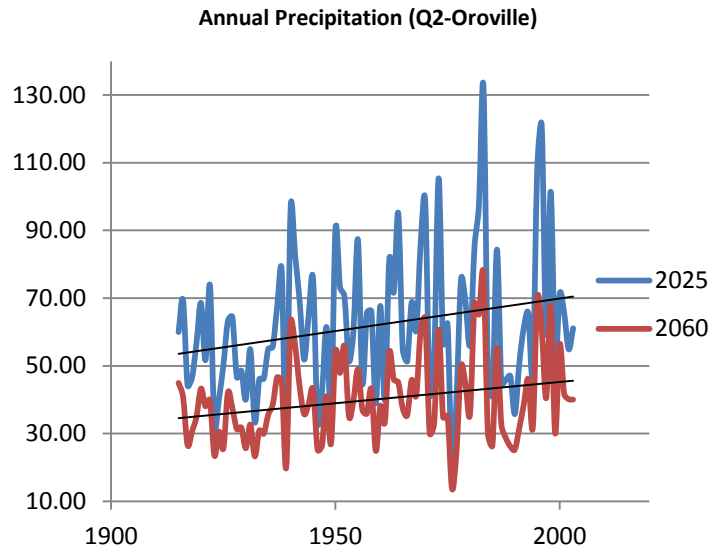

Annual Average Temperature (Q5-Fresno)
70.00
68.00
66.00
64.00
62.00
60.00
58.00
56.00
54.00
1900
1920
1940
1960
1980
2000
2020
2060
2025


Annual Average Temperature (Q5-Millerton)
70.00
68.00
66.00
64.00
62.00
60.00
58.00
56.00
54.00
1900
1920
1940
1960
1980
2000
2020
2060
2025

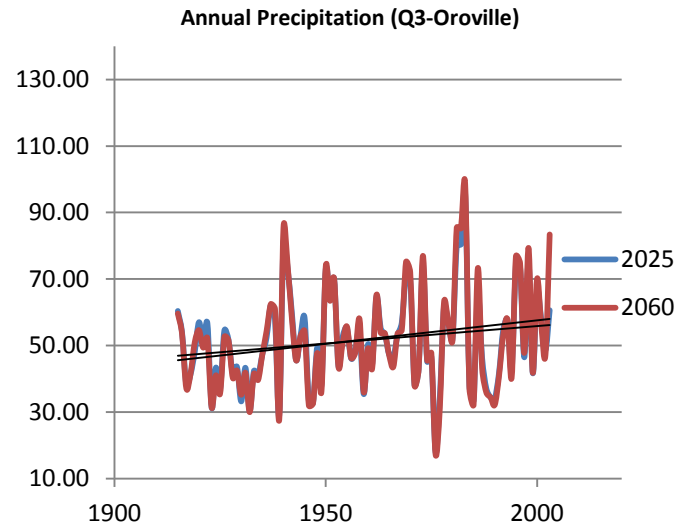
BDCP

Oroville

Precipitation

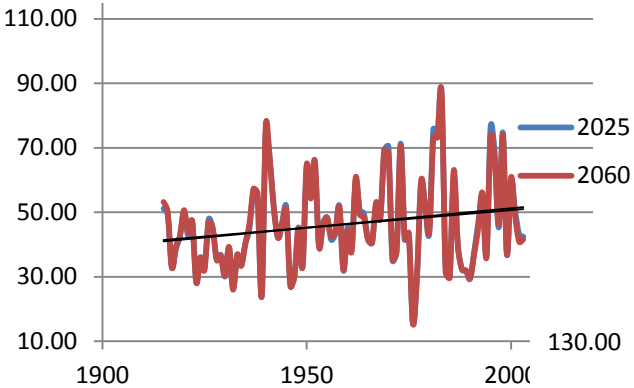


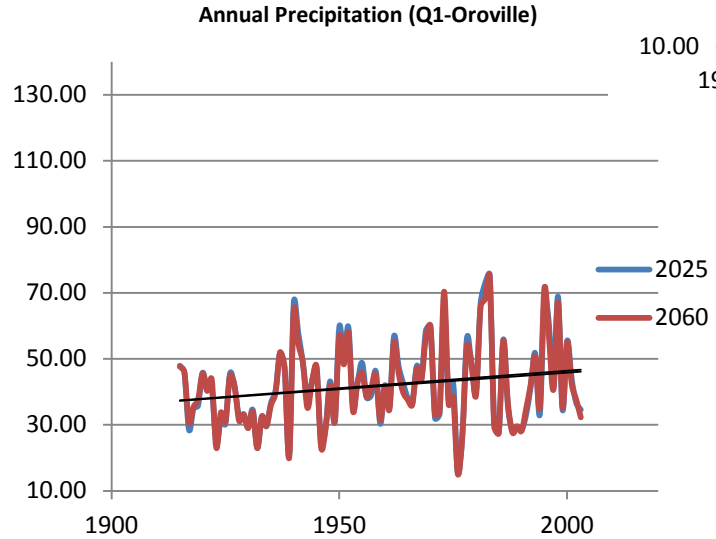
← drier wetter →

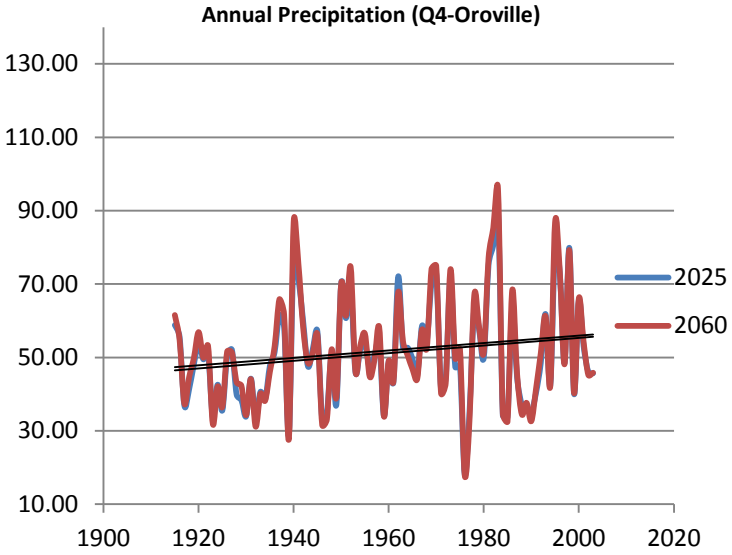


more warming

less warming



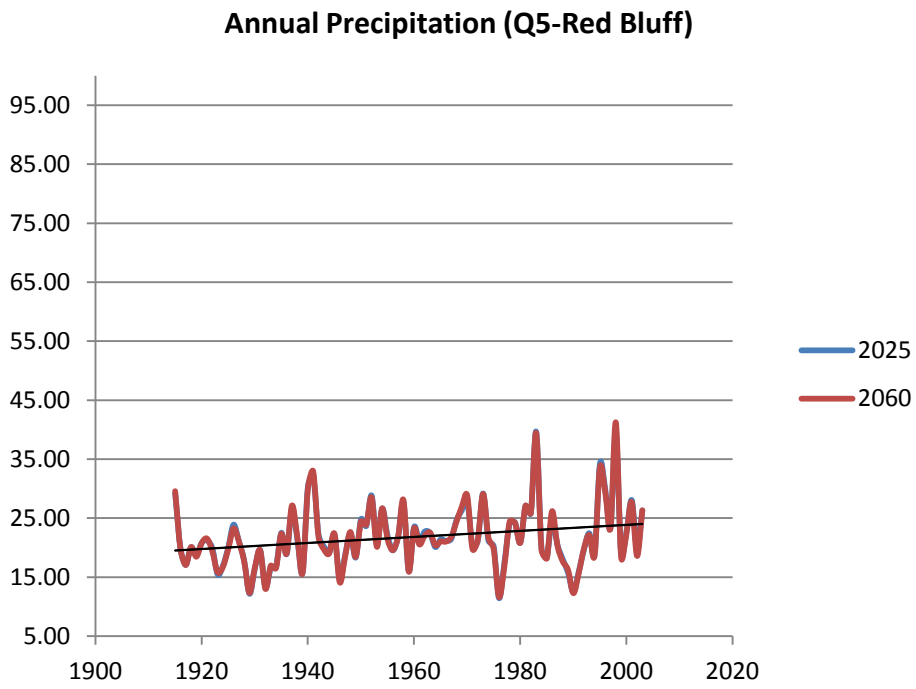


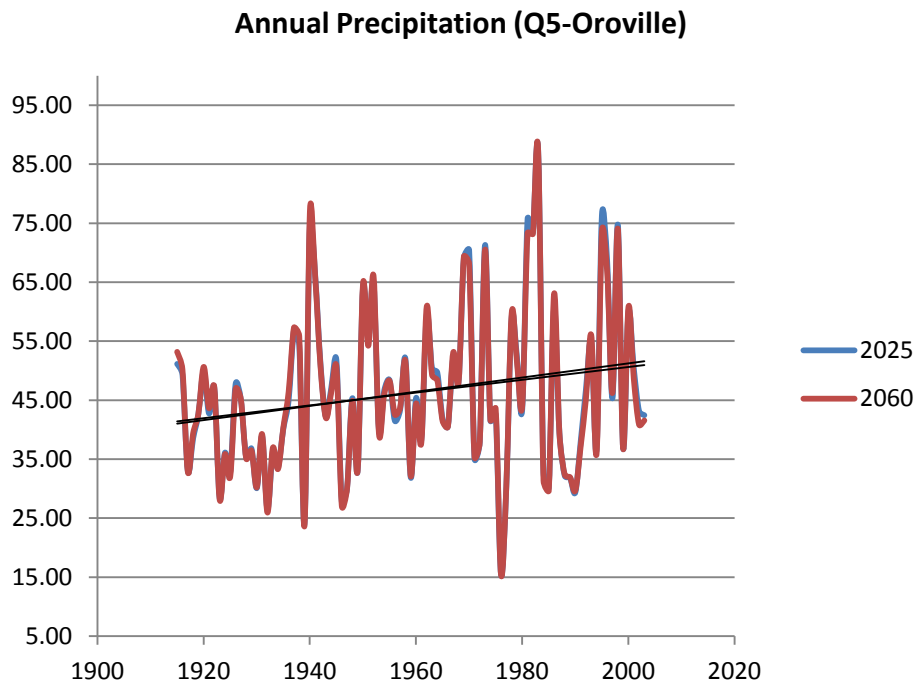


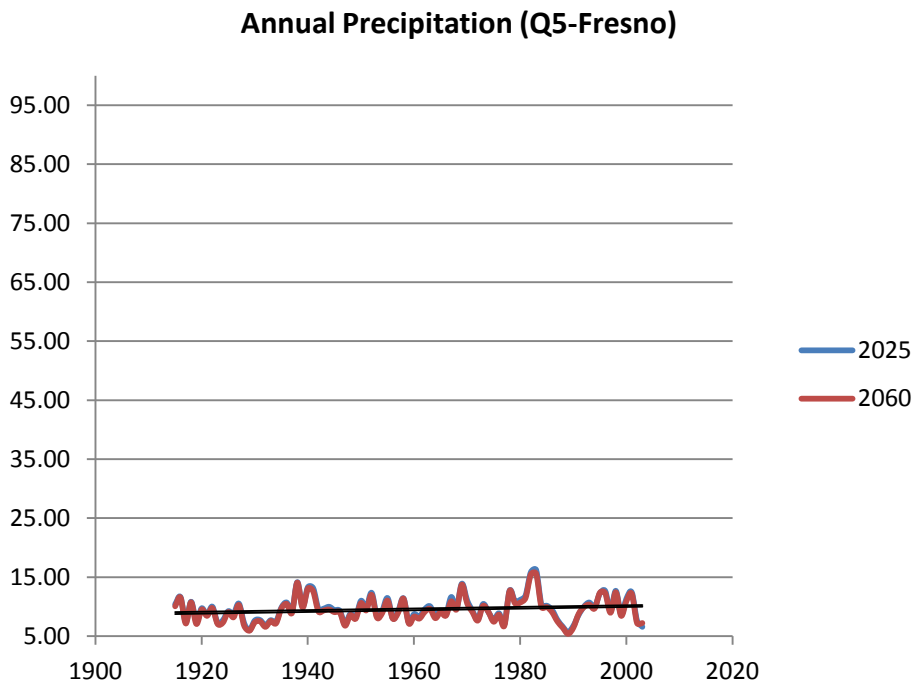
BDCP

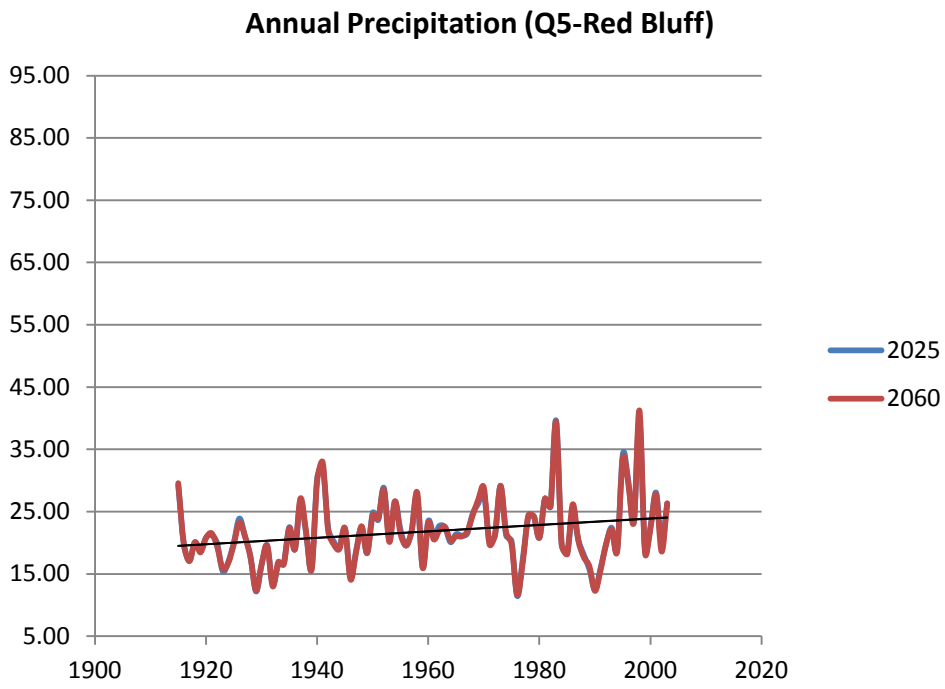
All 4 Locations

Precipitation

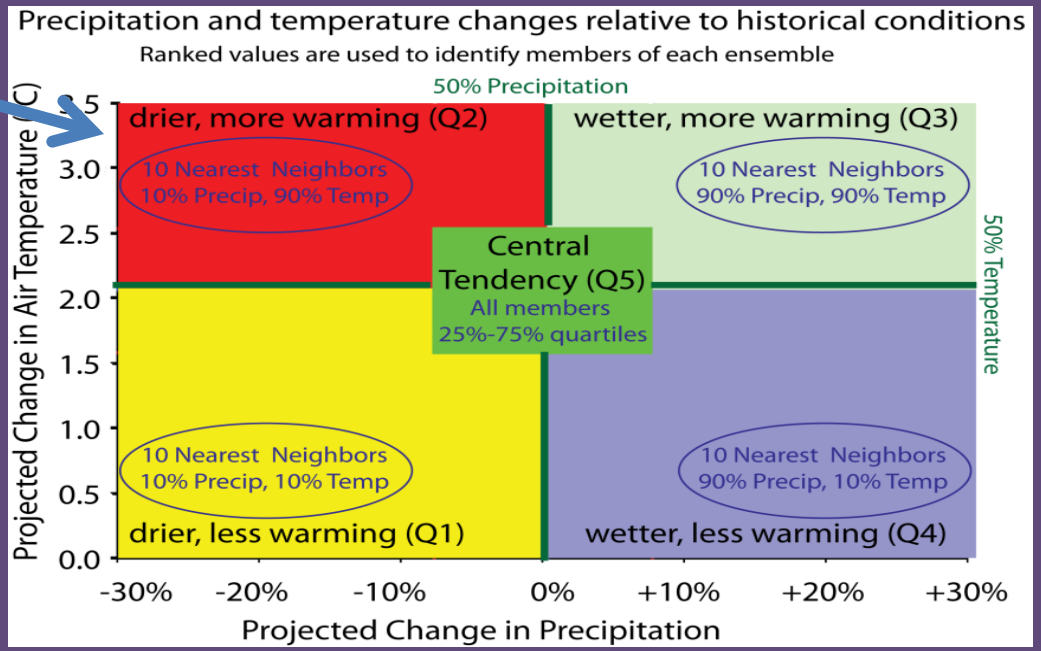

Annual Precipitation (Q5-Red Bluff)
95.00
85.00
75.00
65.00
55.00
45.00
35.00
25.00
15.00
5.00
1900
1920
1940
1960
1980
2000
2020
2025
2060

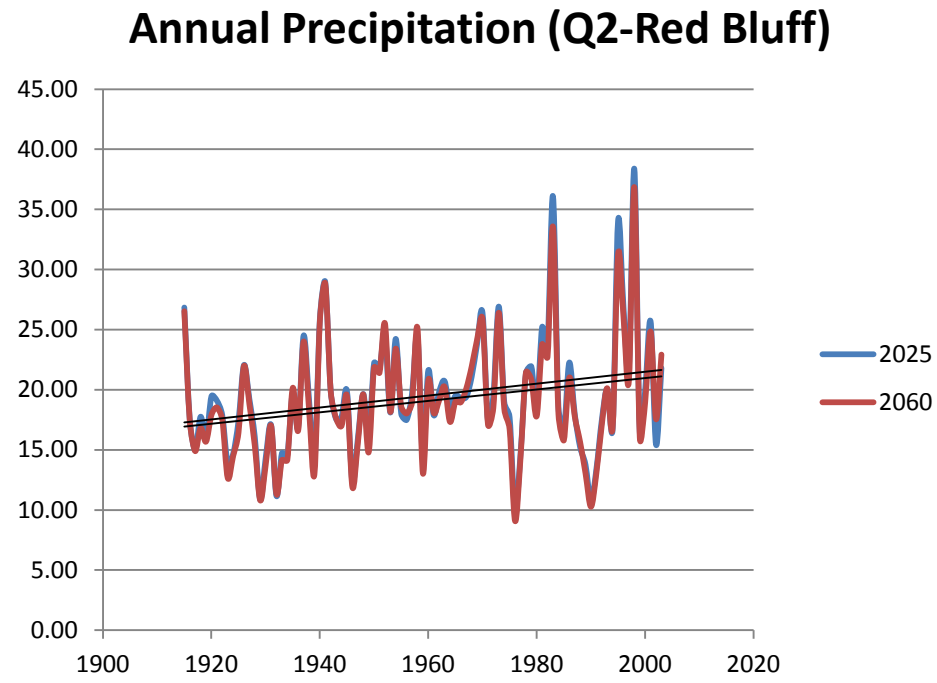

Annual Precipitation (Q5-Oroville)
95.00
85.00
75.00
65.00
55.00
45.00
35.00
25.00
15.00
5.00
1900
1920
1940
1960
1980
2000
2020
2025
2060

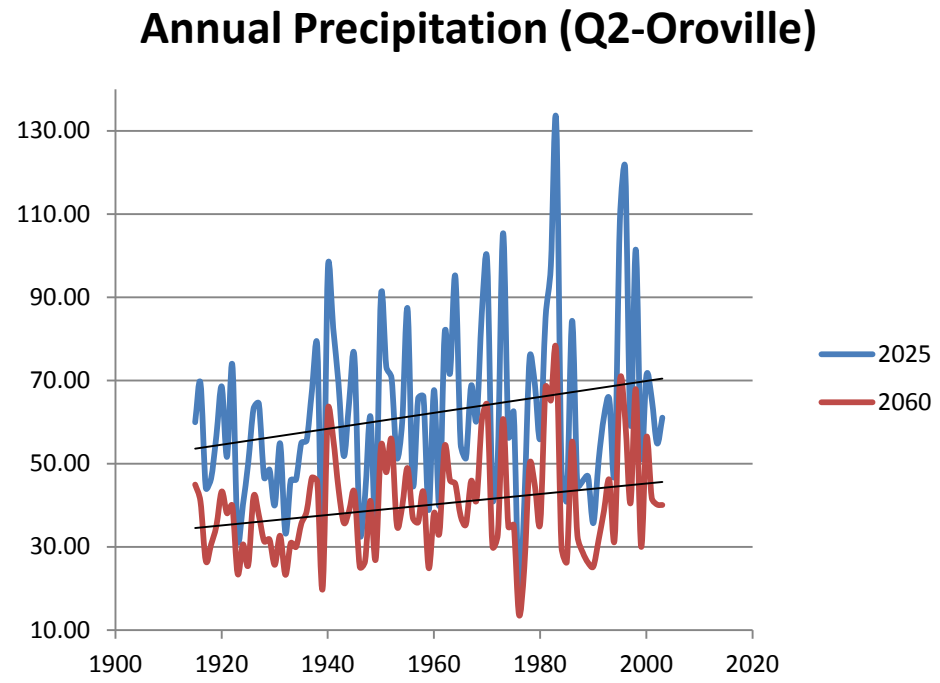

Annual Precipitation (Q5-Fresno)
95.00
85.00
75.00
65.00
55.00
45.00
35.00
25.00
15.00
5.00
1900
1920
1940
1960
1980
2000
2020
2025
2060

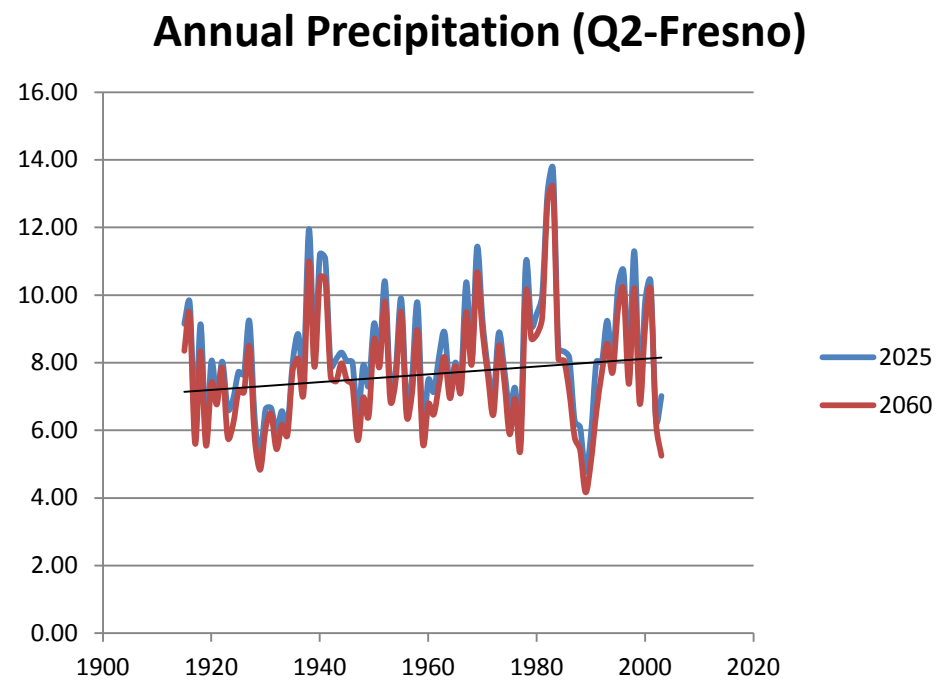

Annual Precipitation (Q5-Red Bluff)
95.00
85.00
75.00
65.00
55.00
45.00
35.00
25.00
15.00
5.00
1900
1920
1940
1960
1980
2000
2020
2025
2060

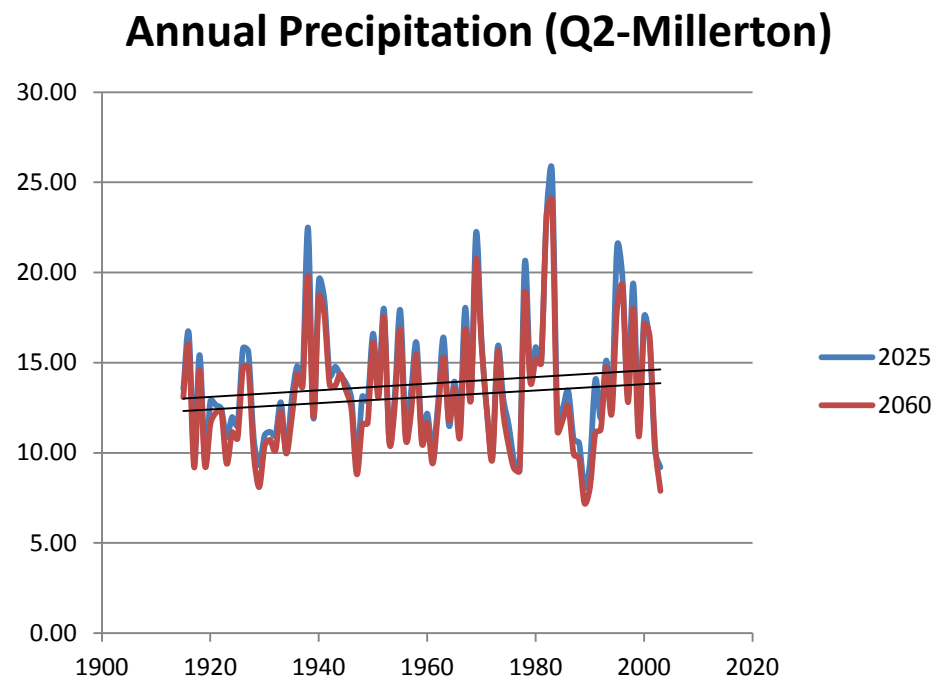
Strange Results in Q2

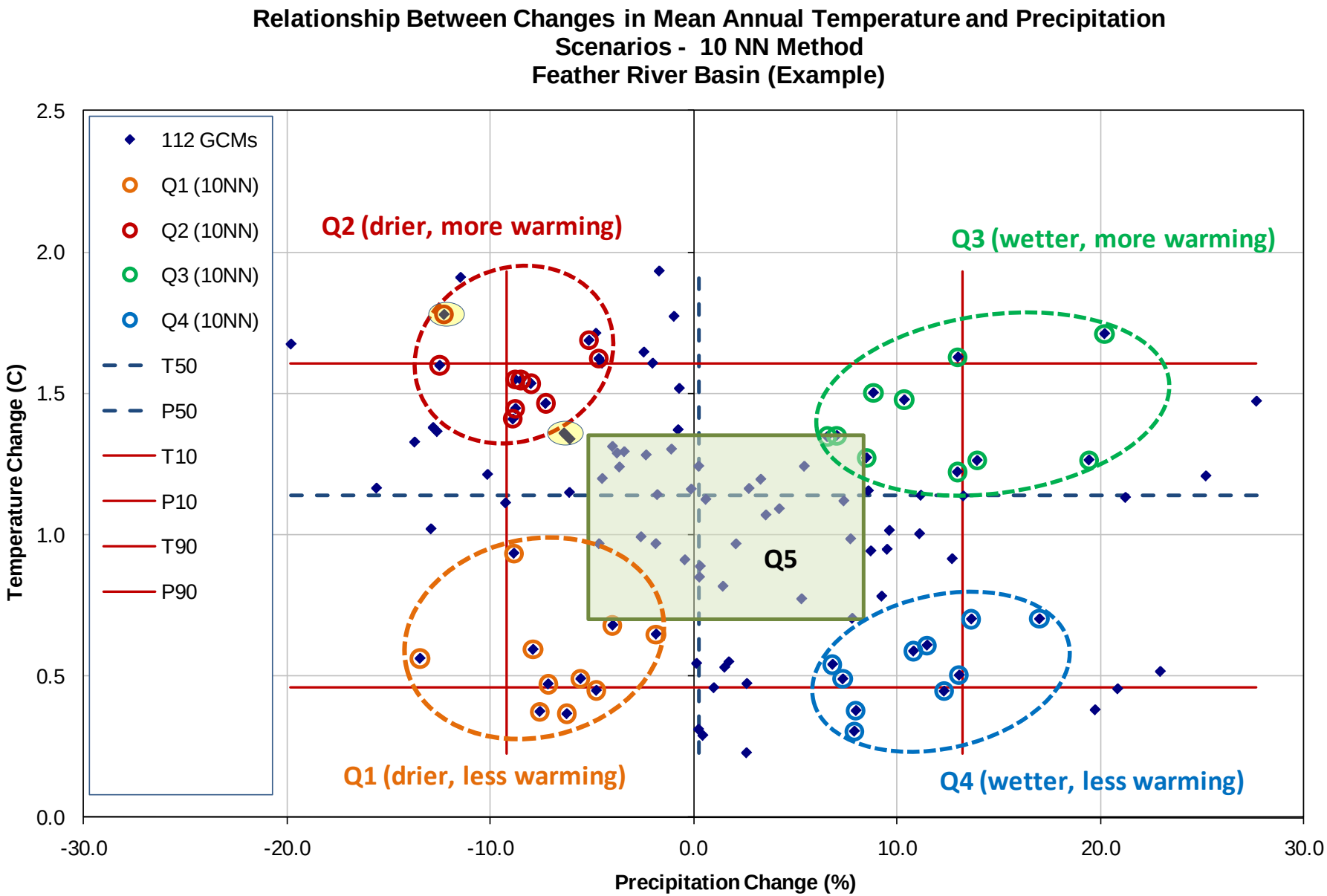



Annual Precipitation (Q2-Red Bluff)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1900
1920
1940
1960
1980
2000
2020
2025
2060


Annual Precipitation (Q2-Oroville)
130.00
110.00
90.00
70.00
50.00
30.00
10.00
1900
1920
1940
1960
1980
2000
2020
2025
2060


Annual Precipitation (Q2-Fresno)
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1900
1920
1940
1960
1980
2000
2020
2025
2060


Annual Precipitation (Q2-Millerton)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1900
1920
1940
1960
1980
2000
2020
2025
2060


Relationship Between Changes in Mean Annual Temperature and Precipitation Scenarios - 10 NN Method
Feather River Basin (Example)
112 GCMs
Q1 (10NN)
Q2 (10NN)
Q3 (10NN)
Q4 (10NN)
T50
P50
T10
P10
T90
P90
Q2 (drier, more warming)
Q3 (wetter, more warming)
Q5
Q1 (drier, less warming)
Q4 (wetter, less warming)
Temperature Change (C)
Precipitation Change (%)
2.5
2.0
1.5
1.0
0.5
0.0
-30.0
-20.0
-10.0
0.0
10.0
20.0
30.0

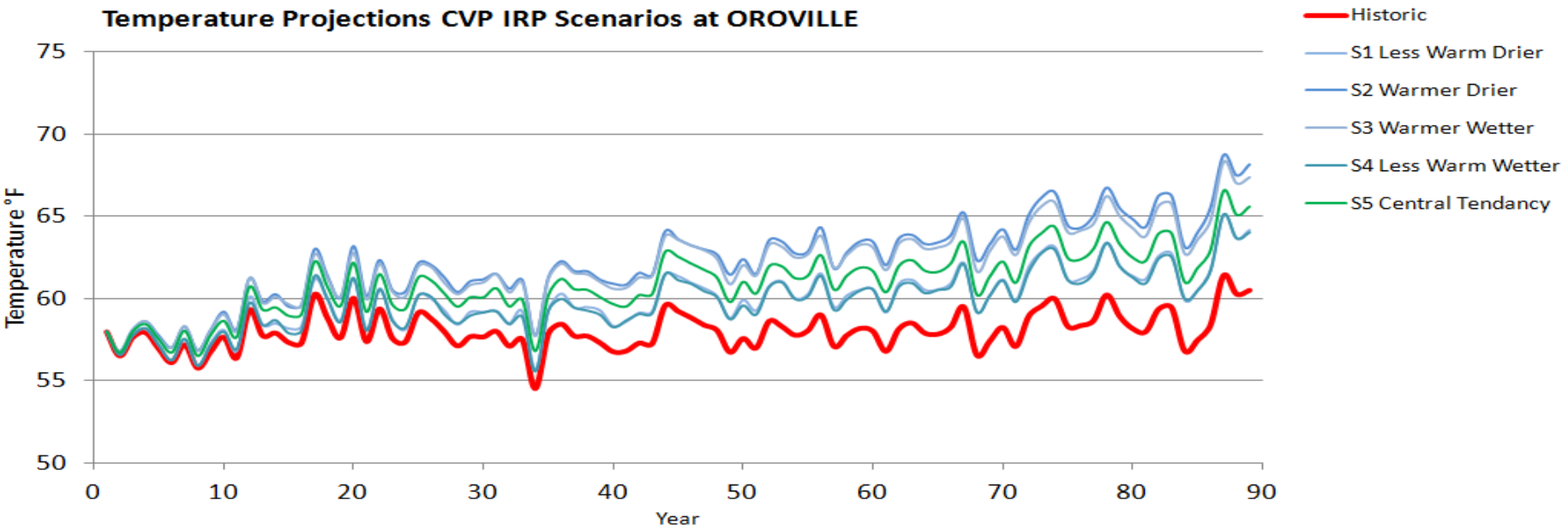
Central Valley Project-Integrated Resource Plan (CVP-IRP) Approach

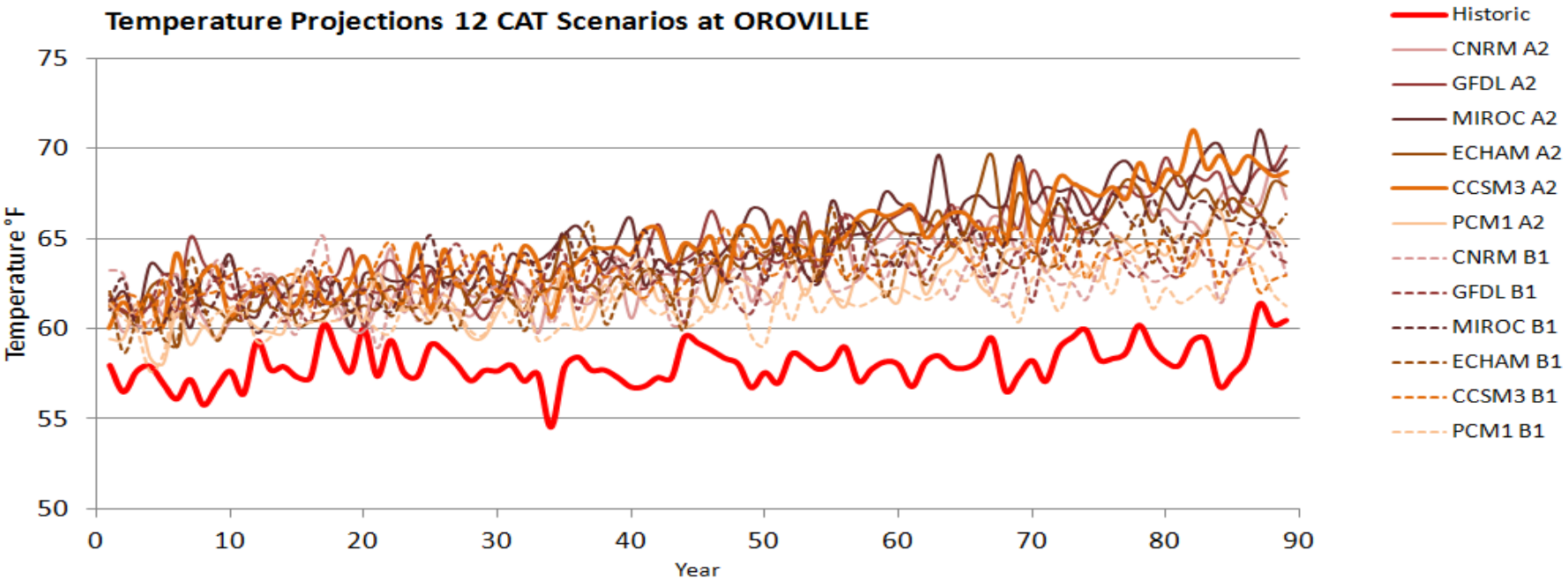
CVP-IRP

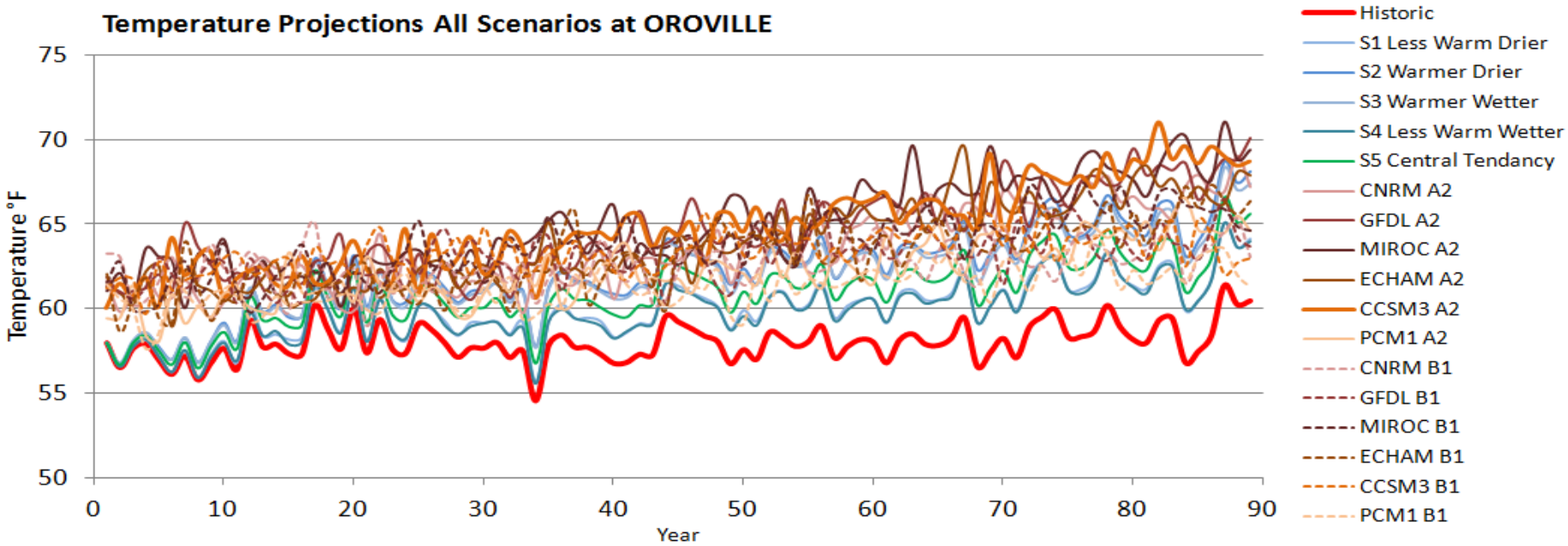
- Same 5 ensembles used by BDCP
- Maps back to historical temperature and precipitation record 1915-2003
- Climate statistics are calculated at 4 different points between 2000 and 2099 and interpolated to define the unique climate statistics for every year.
- **Climate evolves through simulation.**

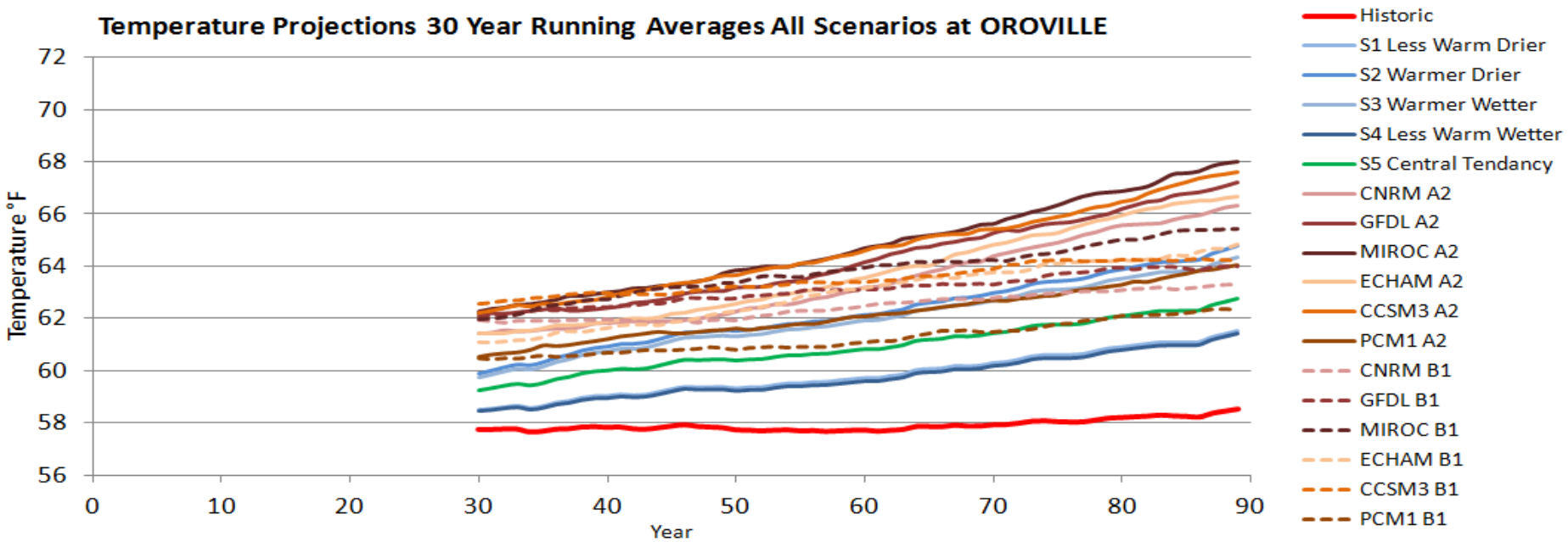
Oroville

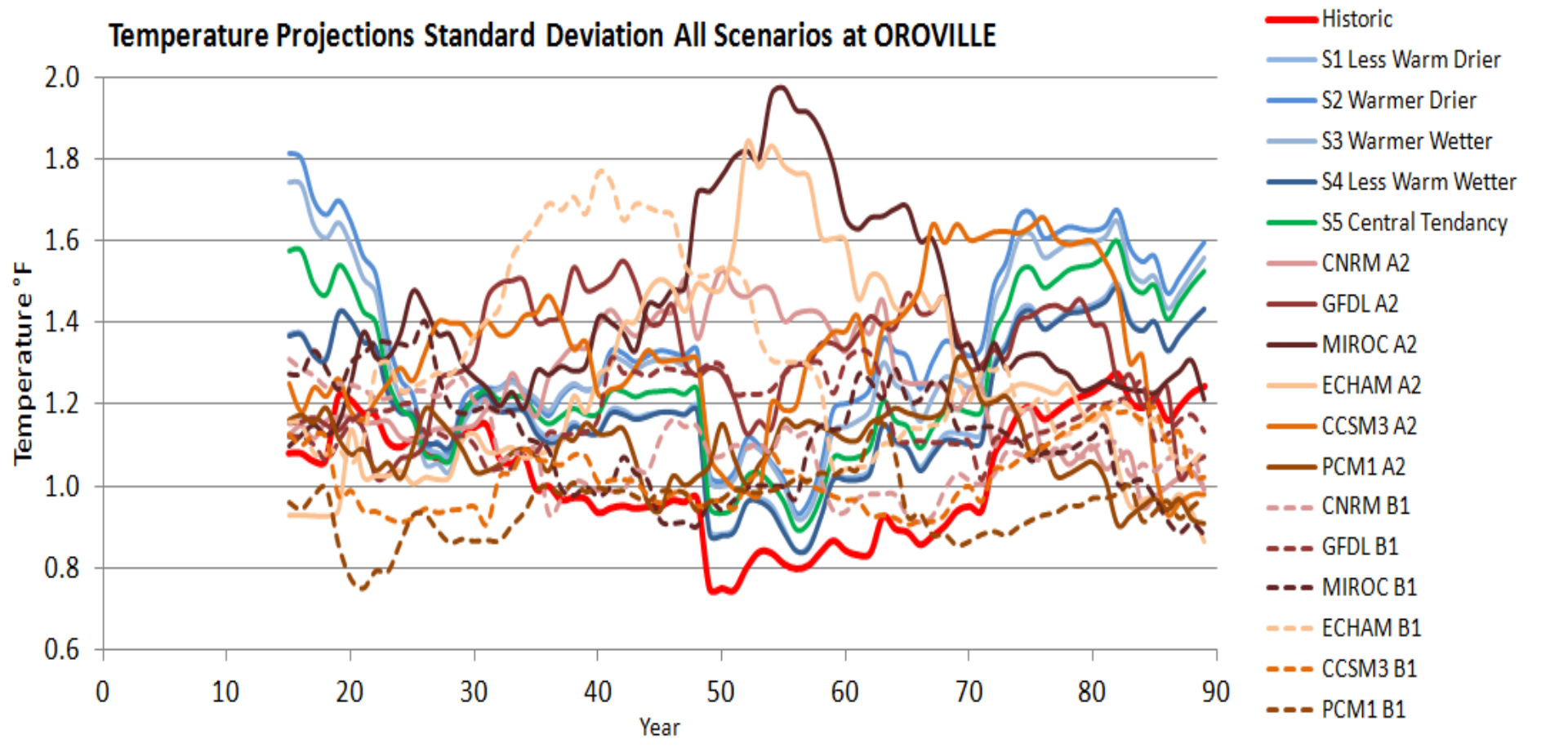
Temperature


Temperature Projections CVP IRP Scenarios at OROVILLE
Temperature °F
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy


Temperature Projections 12 CAT Scenarios at OROVILLE
Temperature °F
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
Year
Historic
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

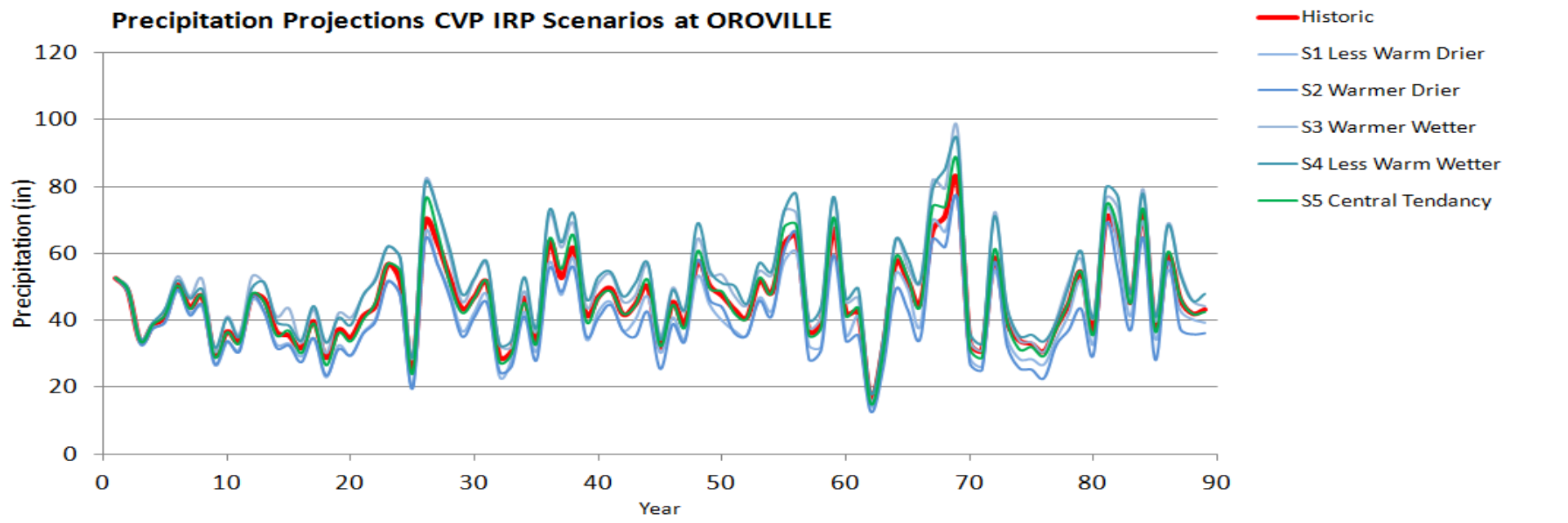

Temperature Projections All Scenarios at OROVILLE
Temperature °F
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

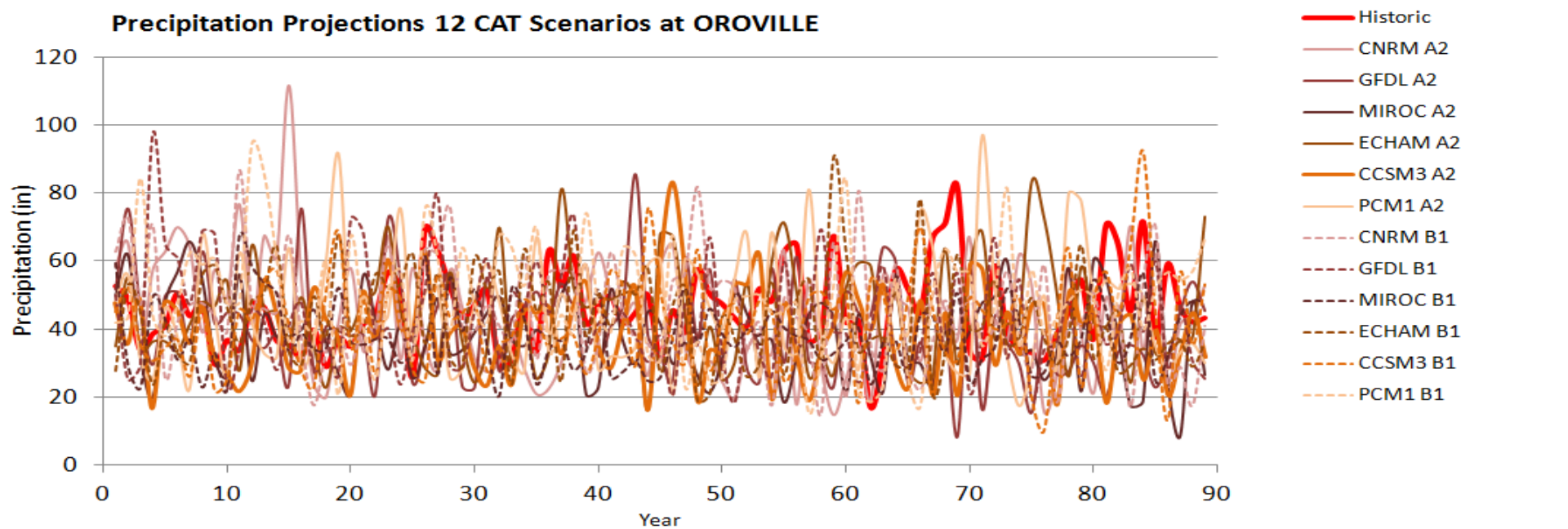

Temperature Projections 30 Year Running Averages All Scenarios at OROVILLE
Temperature °F
72
70
68
66
64
62
60
58
56
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

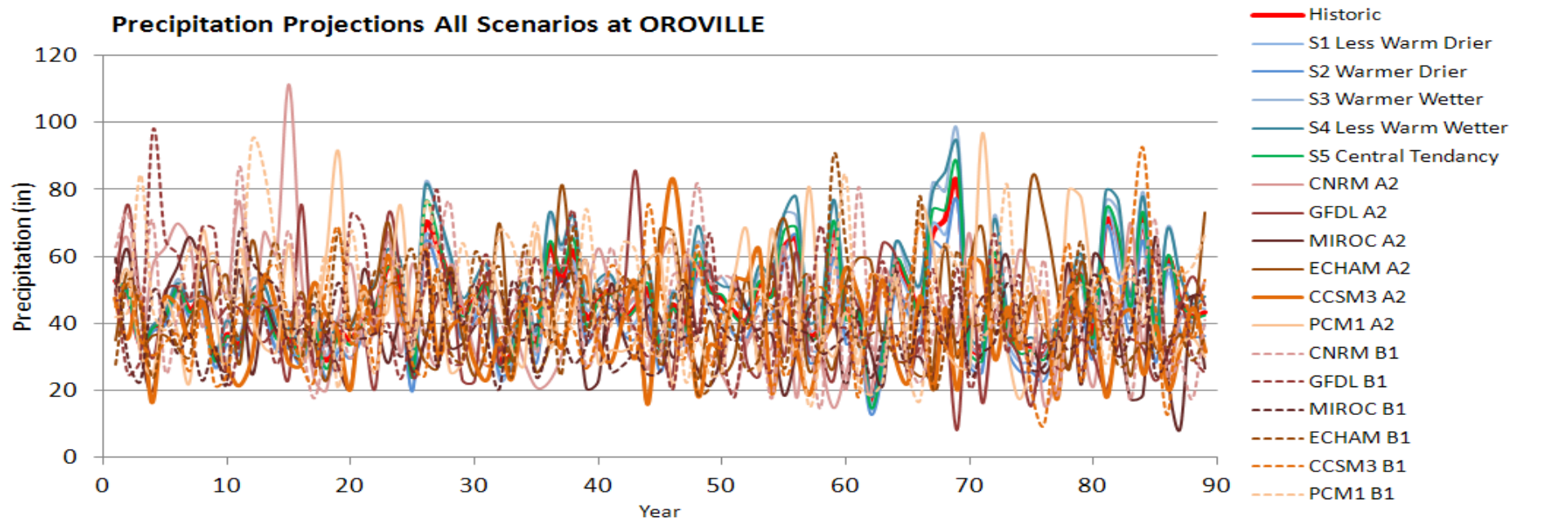

Temperature Projections Standard Deviation All Scenarios at OROVILLE
Temperature °F
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

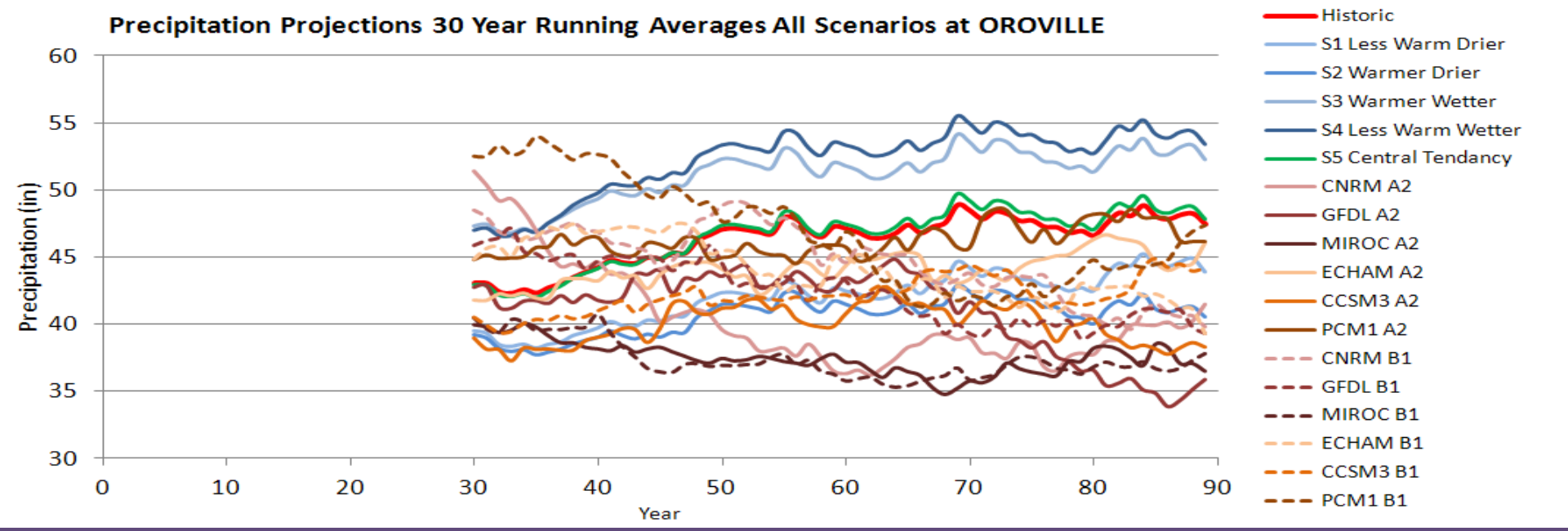
Oroville

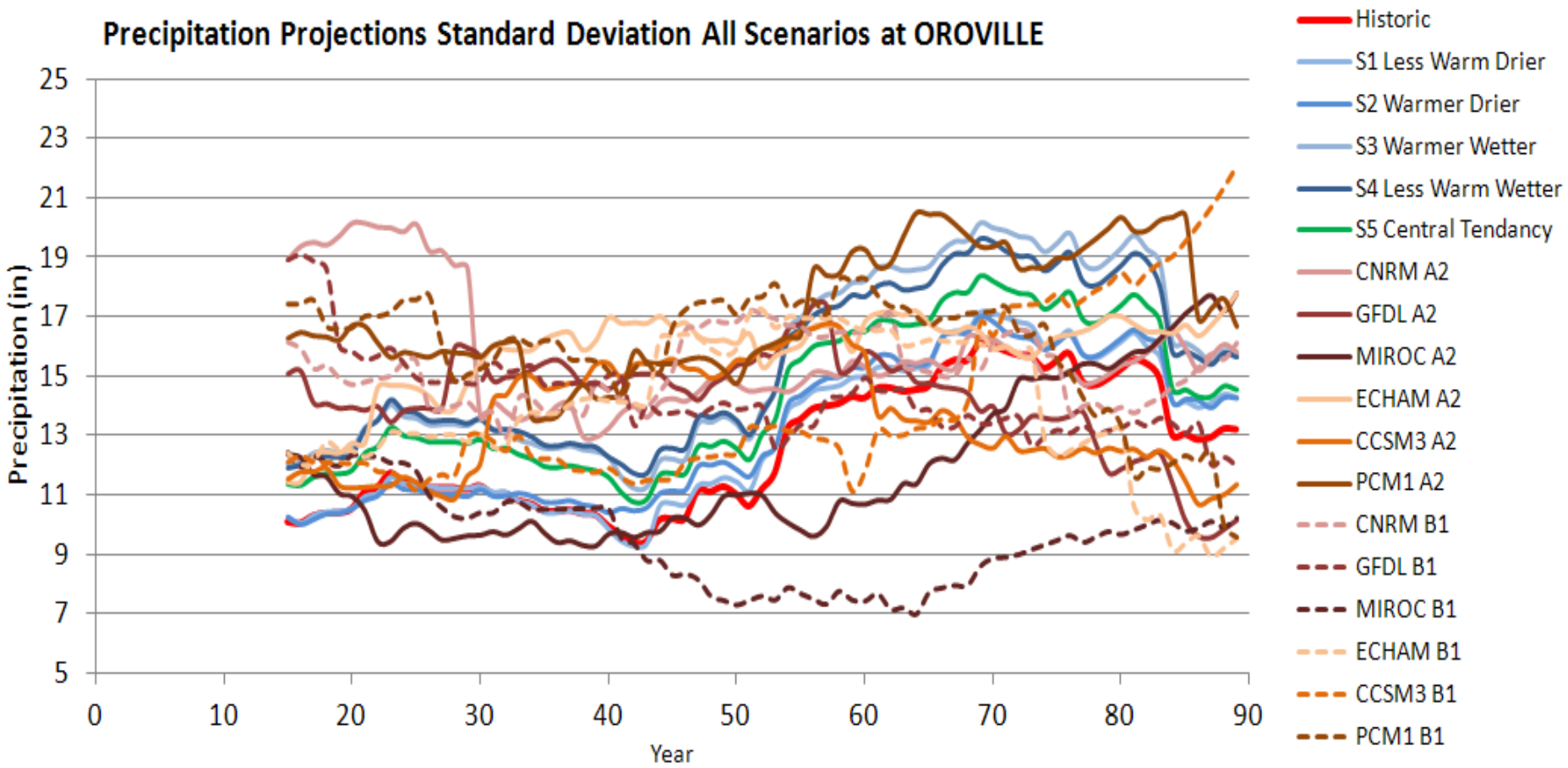
Precipitation


Precipitation Projections CVP IRP Scenarios at OROVILLE
Precipitation (in)
Year
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy


Precipitation Projections 12 CAT Scenarios at OROVILLE
Precipitation (in)
Year
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
Historic
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

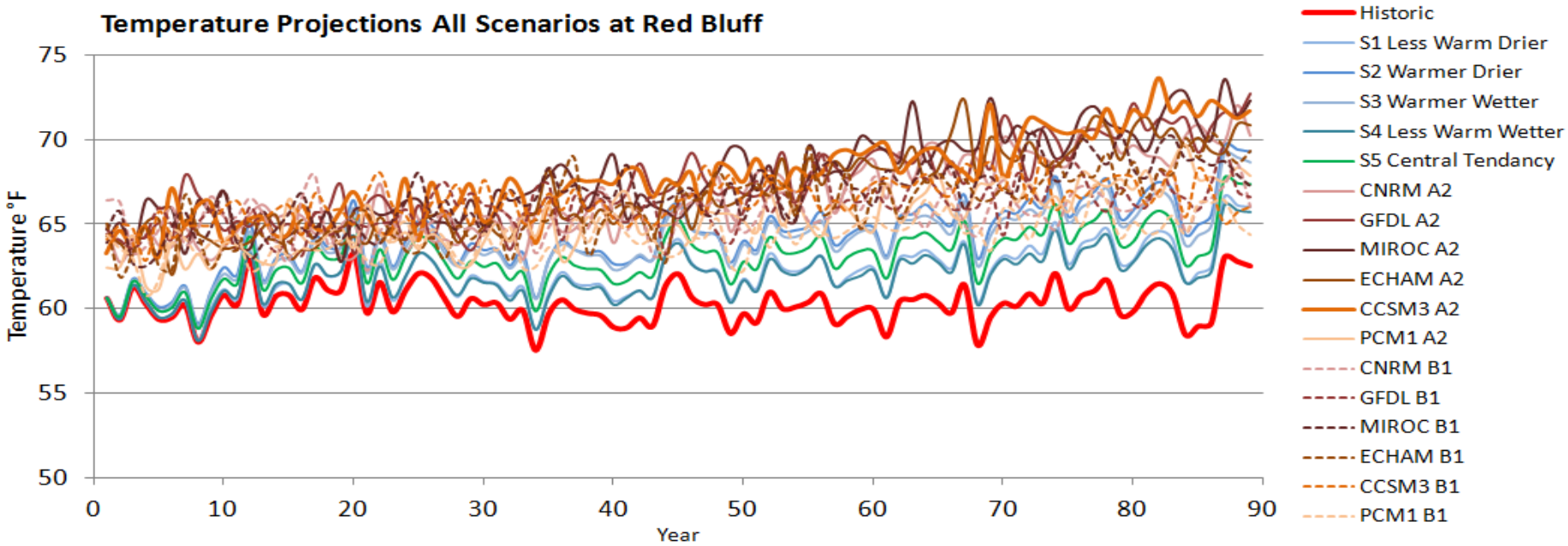

Precipitation Projections All Scenarios at OROVILLE
Precipitation (in)
Year
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

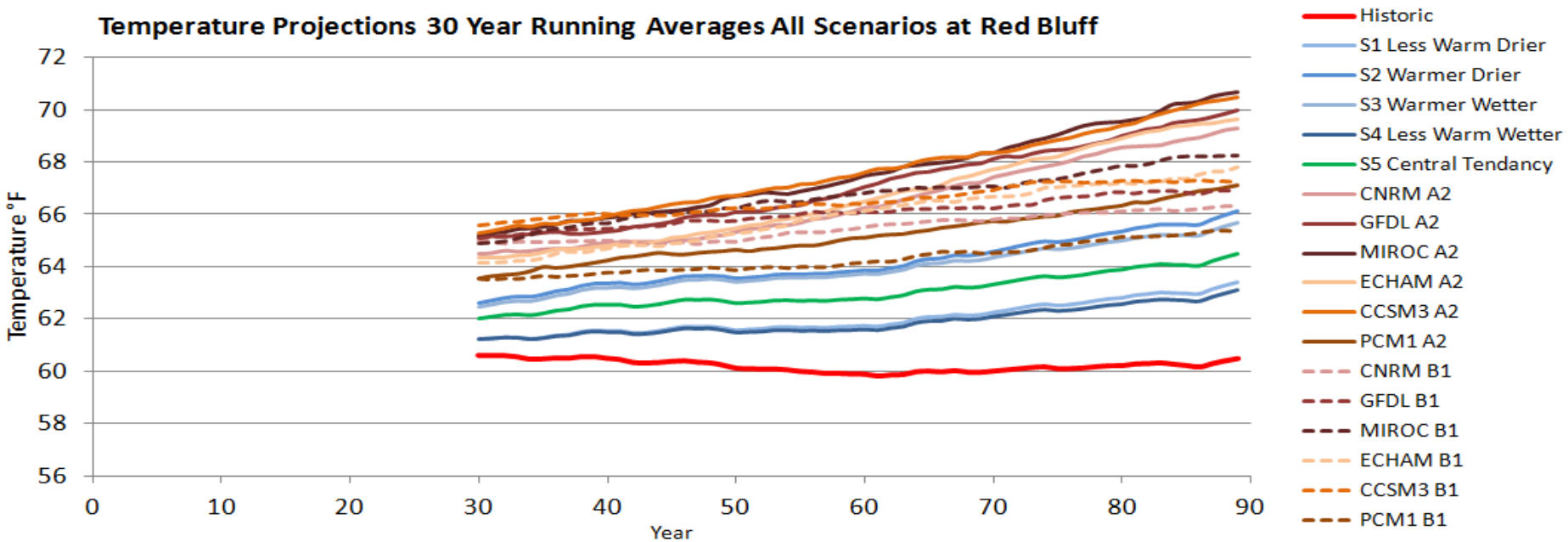

Precipitation Projections 30 Year Running Averages All Scenarios at OROVILLE
Precipitation (in)
Year
30
35
40
45
50
55
60
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

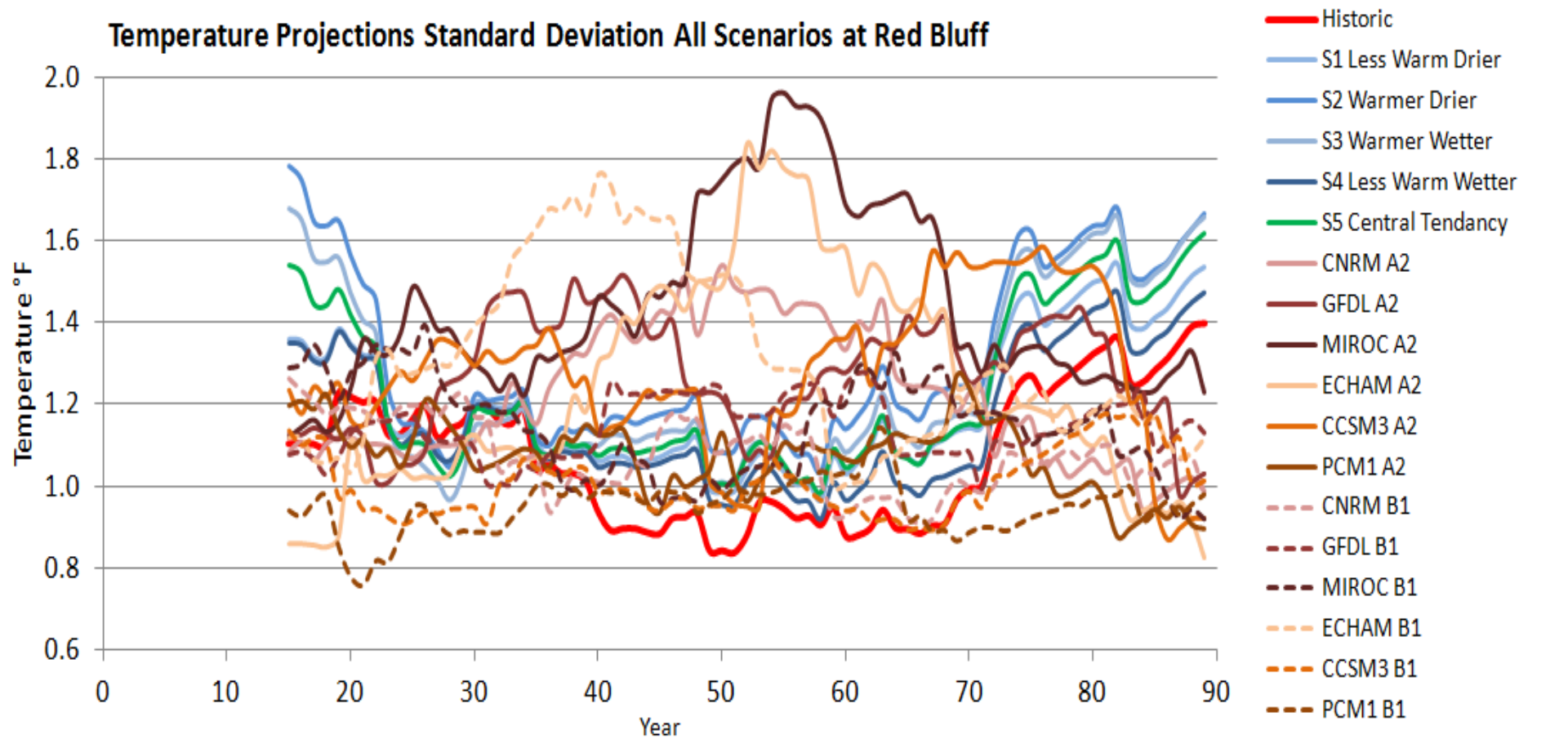

Precipitation Projections Standard Deviation All Scenarios at OROVILLE
Precipitation (in)
25
23
21
19
17
15
13
11
9
7
5
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

Red Bluff

Temperature

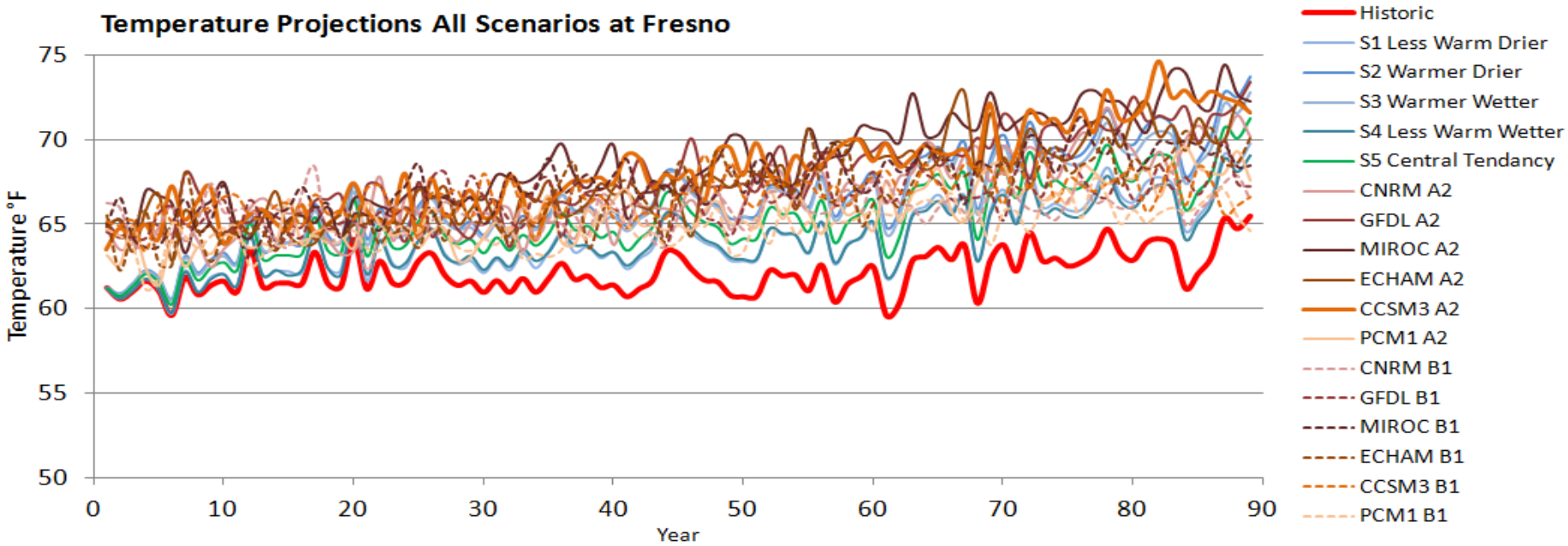

Temperature Projections All Scenarios at Red Bluff
Temperature °F
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

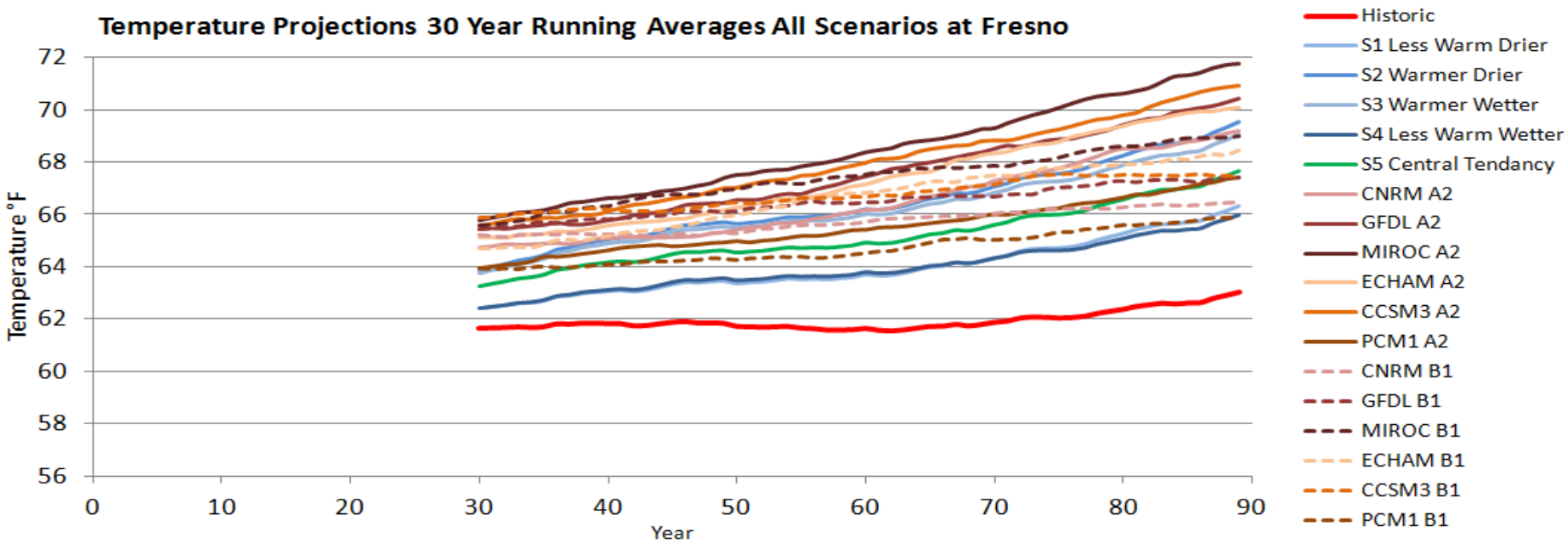

Temperature Projections 30 Year Running Averages All Scenarios at Red Bluff
Temperature °F
72
70
68
66
64
62
60
58
56
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

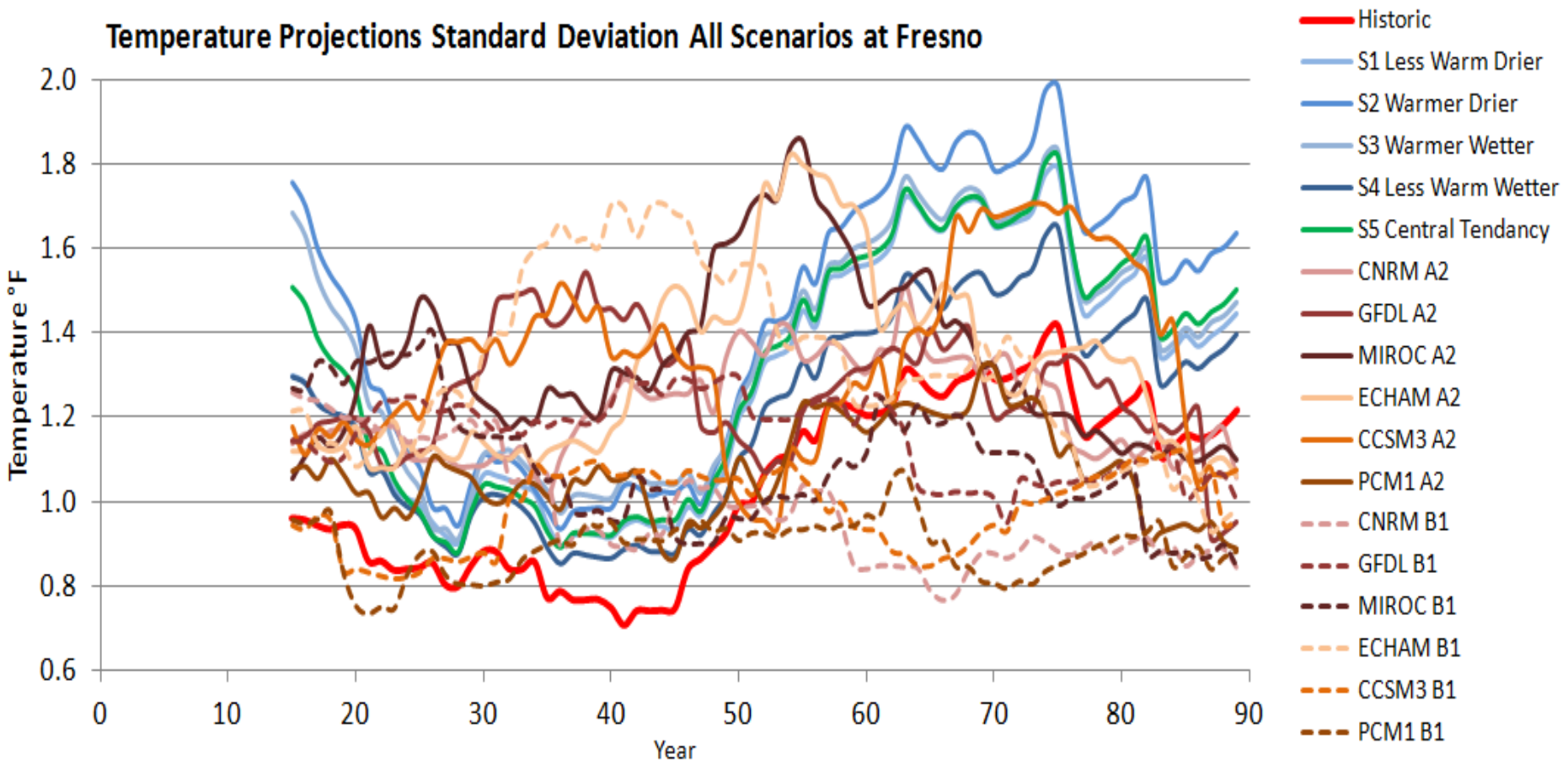

Temperature Projections Standard Deviation All Scenarios at Red Bluff
Temperature °F
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

Fresno

Temperature

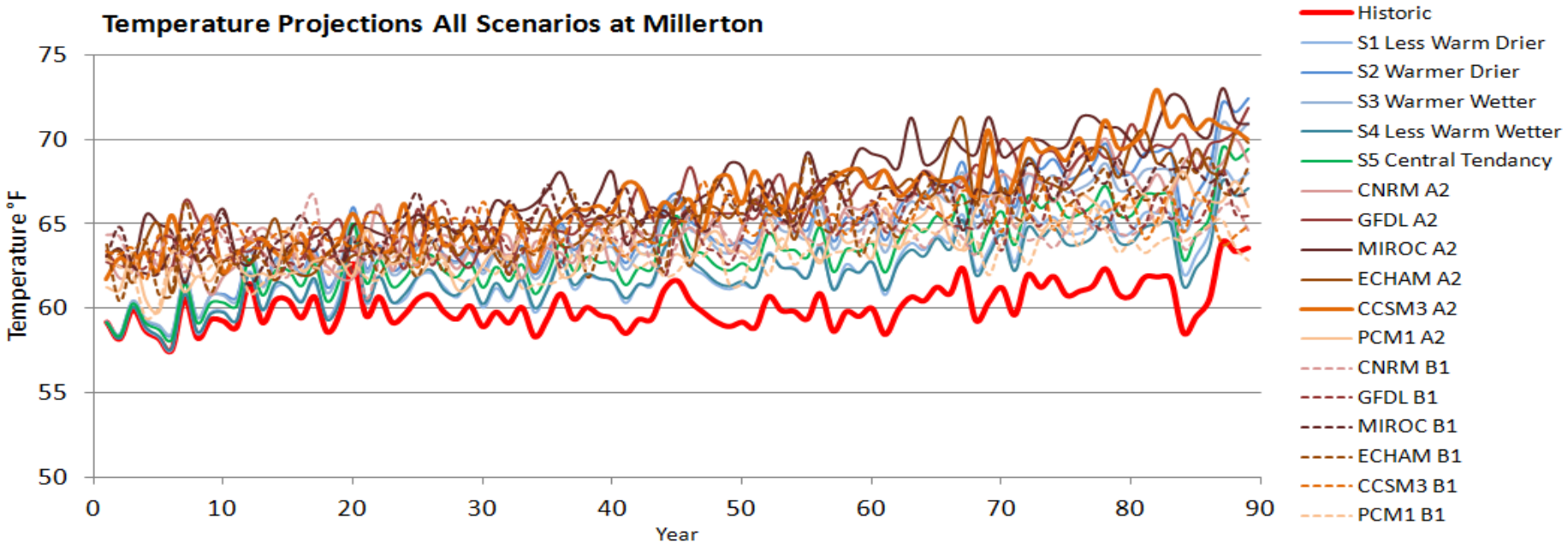

Temperature Projections All Scenarios at Fresno
Temperature °F
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

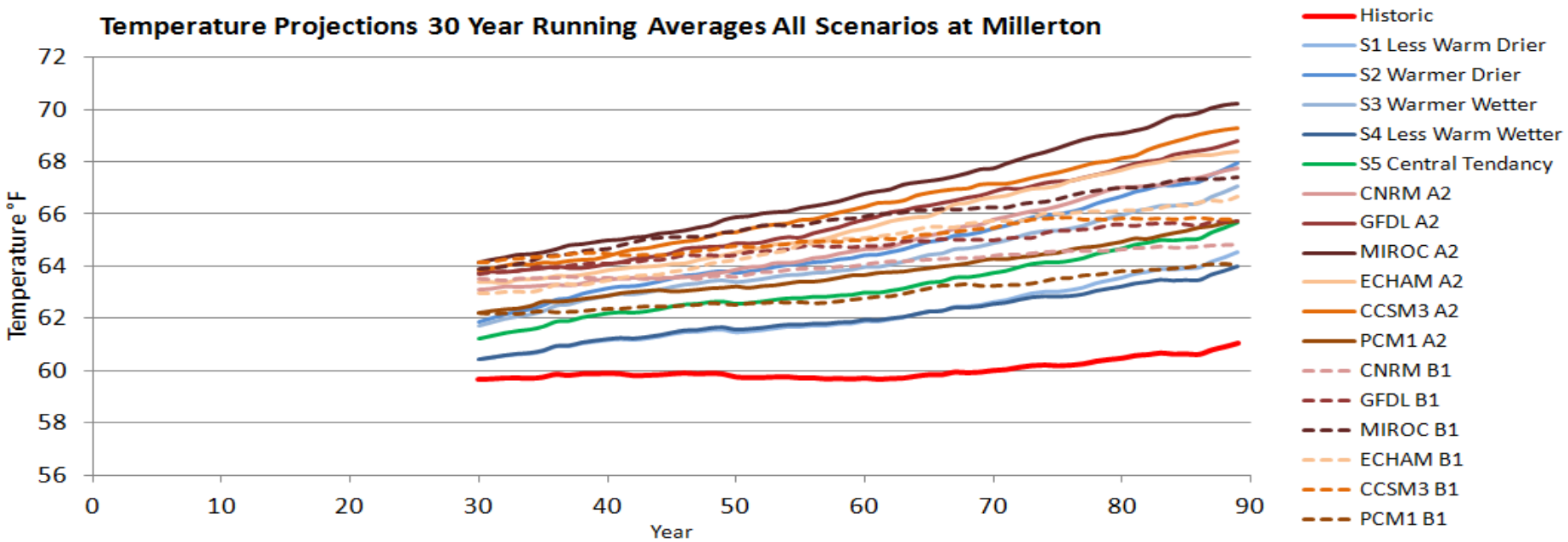

Temperature Projections 30 Year Running Averages All Scenarios at Fresno
Temperature °F
72
70
68
66
64
62
60
58
56
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

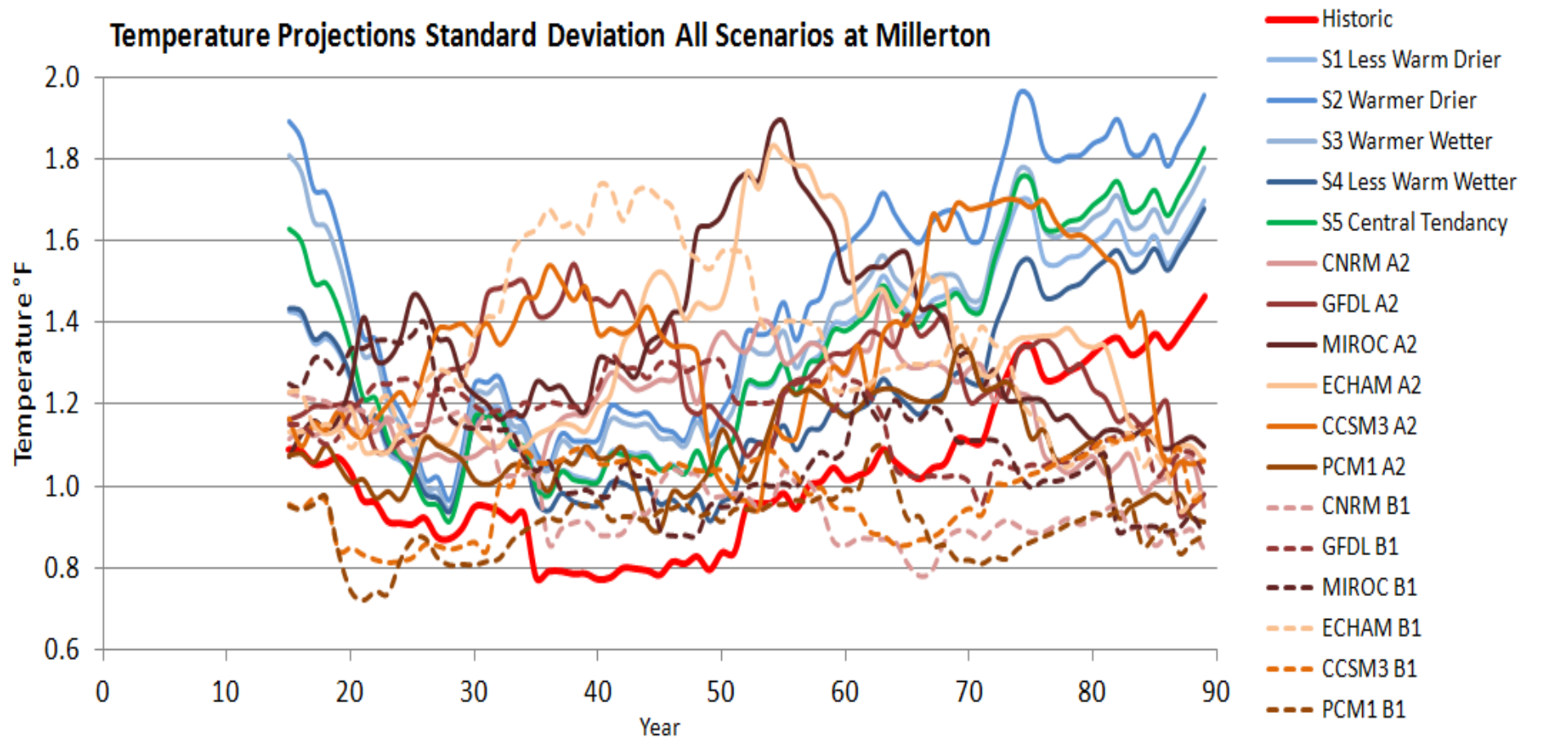

Temperature Projections Standard Deviation All Scenarios at Fresno
Temperature °F
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

Millerton

Temperature

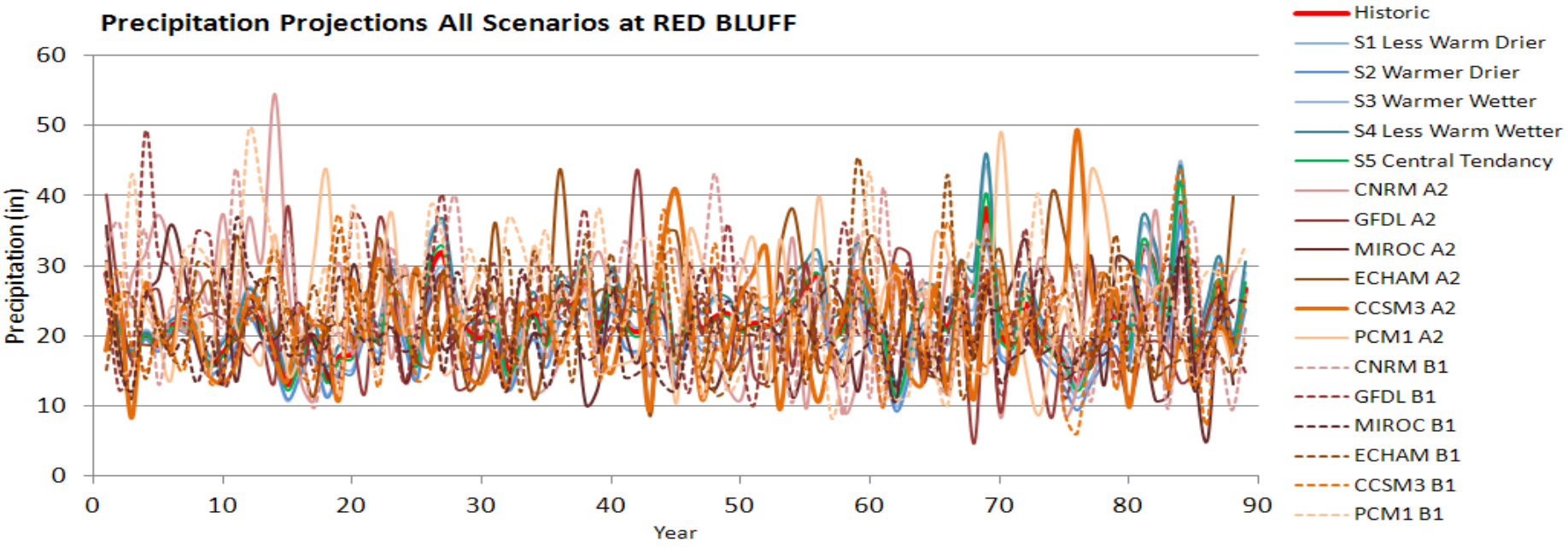

Temperature Projections All Scenarios at Millerton
Temperature °F
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

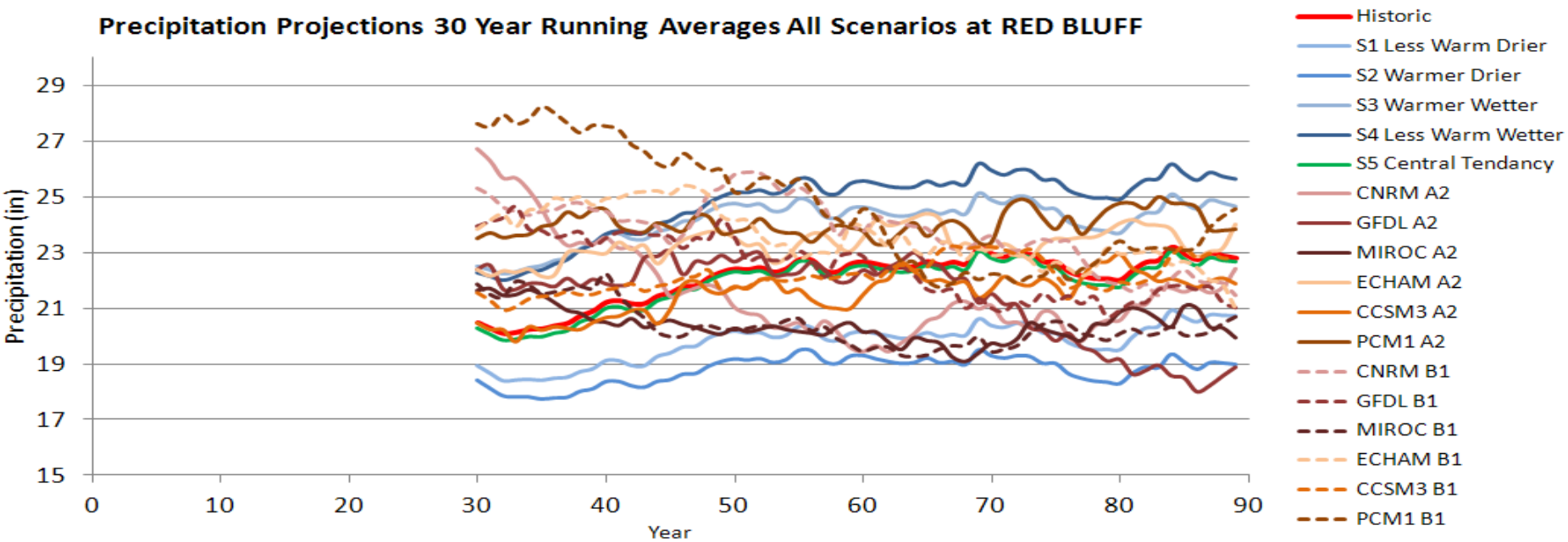

Temperature Projections 30 Year Running Averages All Scenarios at Millerton
Temperature °F
72
70
68
66
64
62
60
58
56
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

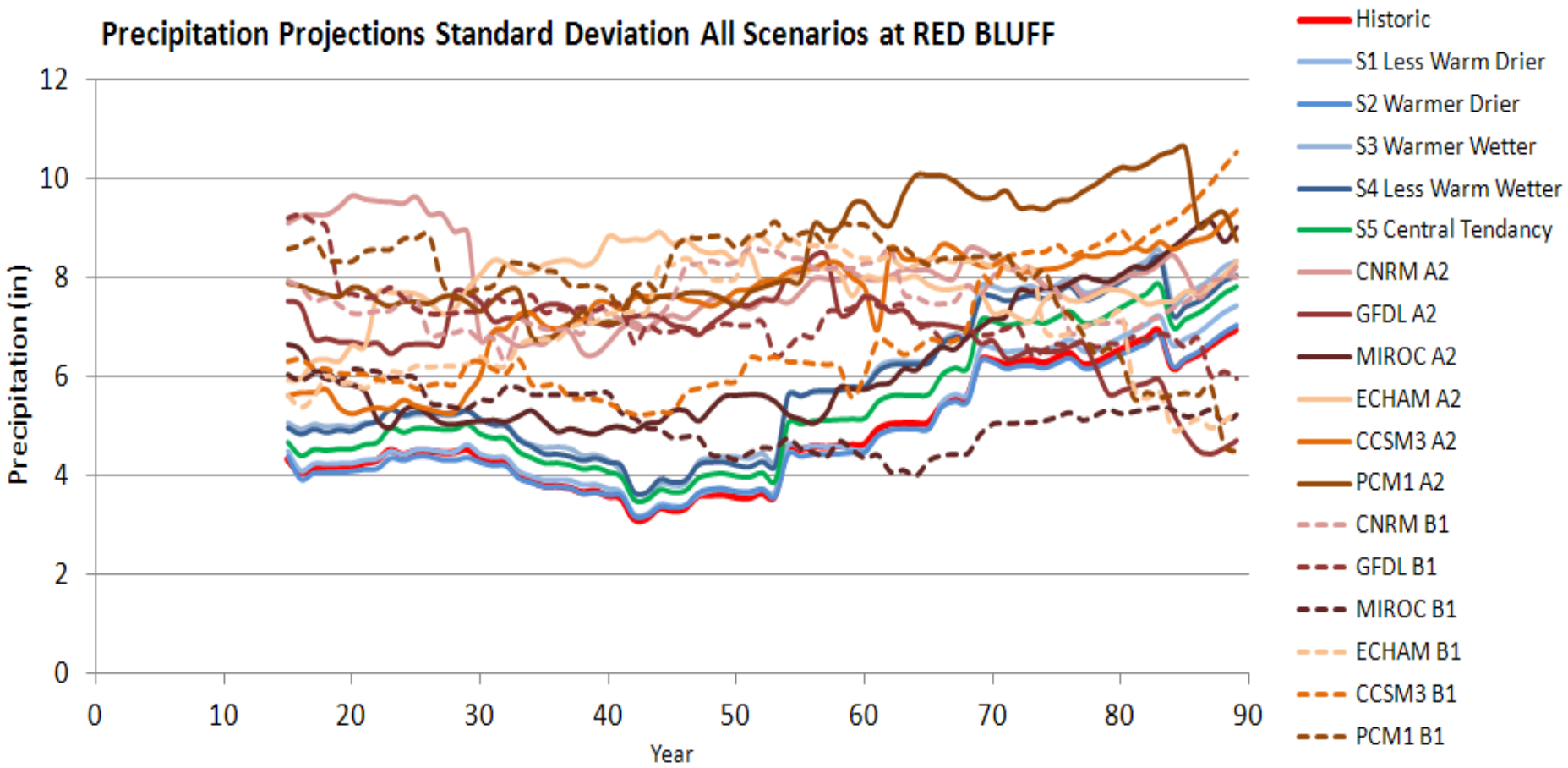

Temperature Projections Standard Deviation All Scenarios at Millerton
Temperature °F
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

Red Bluff

Precipitation

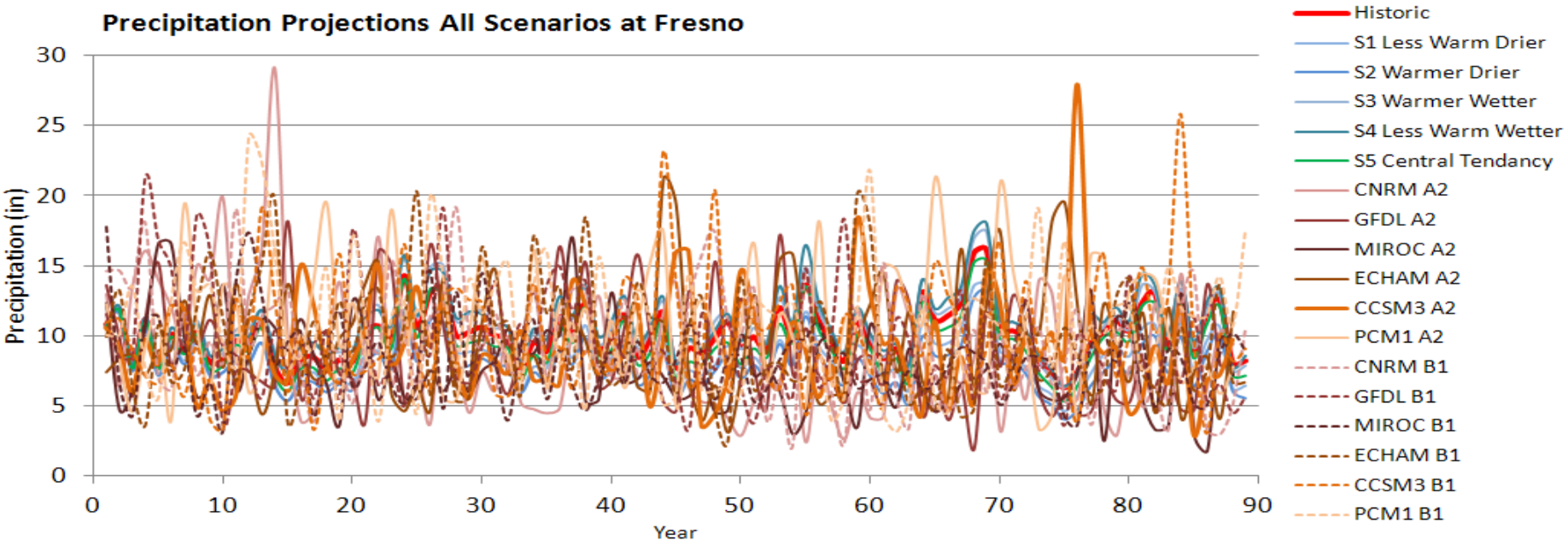

Precipitation Projections All Scenarios at RED BLUFF
Precipitation (in)
Year
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

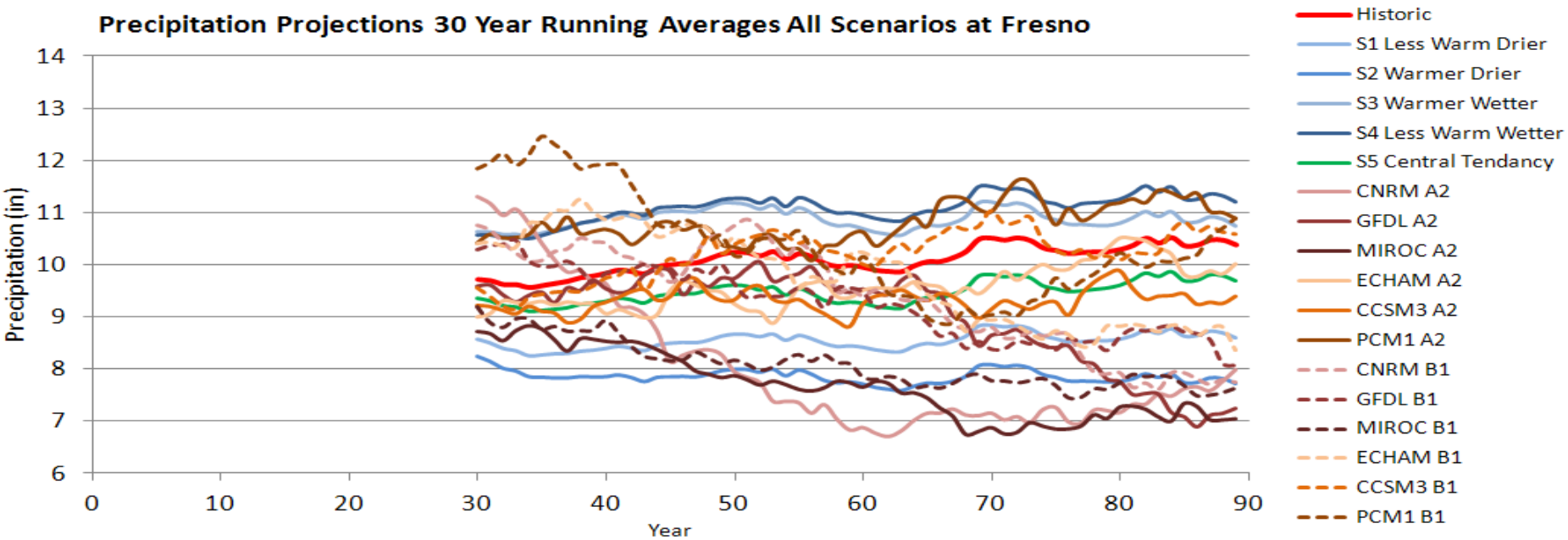

Precipitation Projections 30 Year Running Averages All Scenarios at RED BLUFF
Precipitation (in)
Year
15
17
19
21
23
25
27
29
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

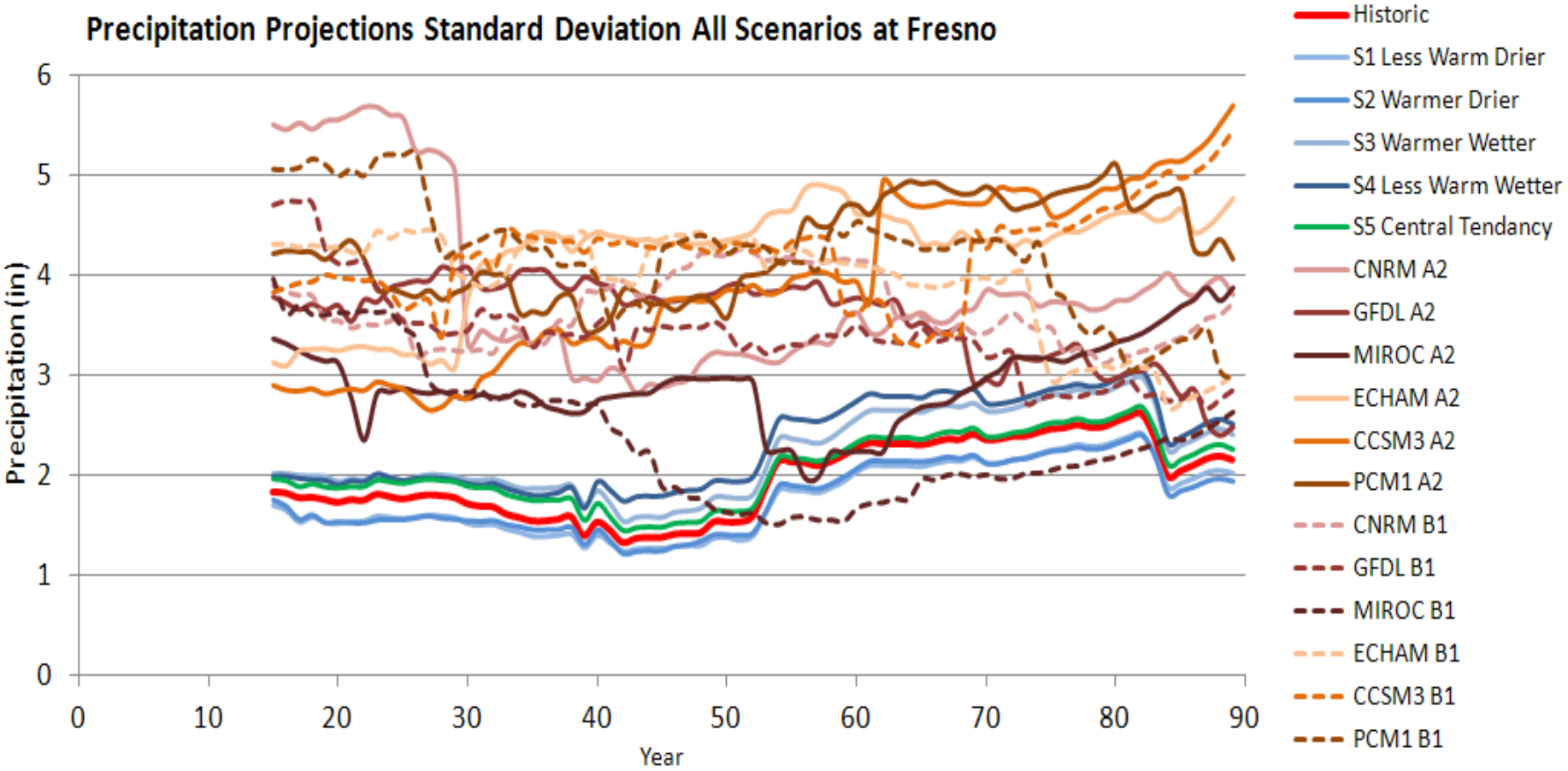

Precipitation Projections Standard Deviation All Scenarios at RED BLUFF
Precipitation (in)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

Fresno

Precipitation

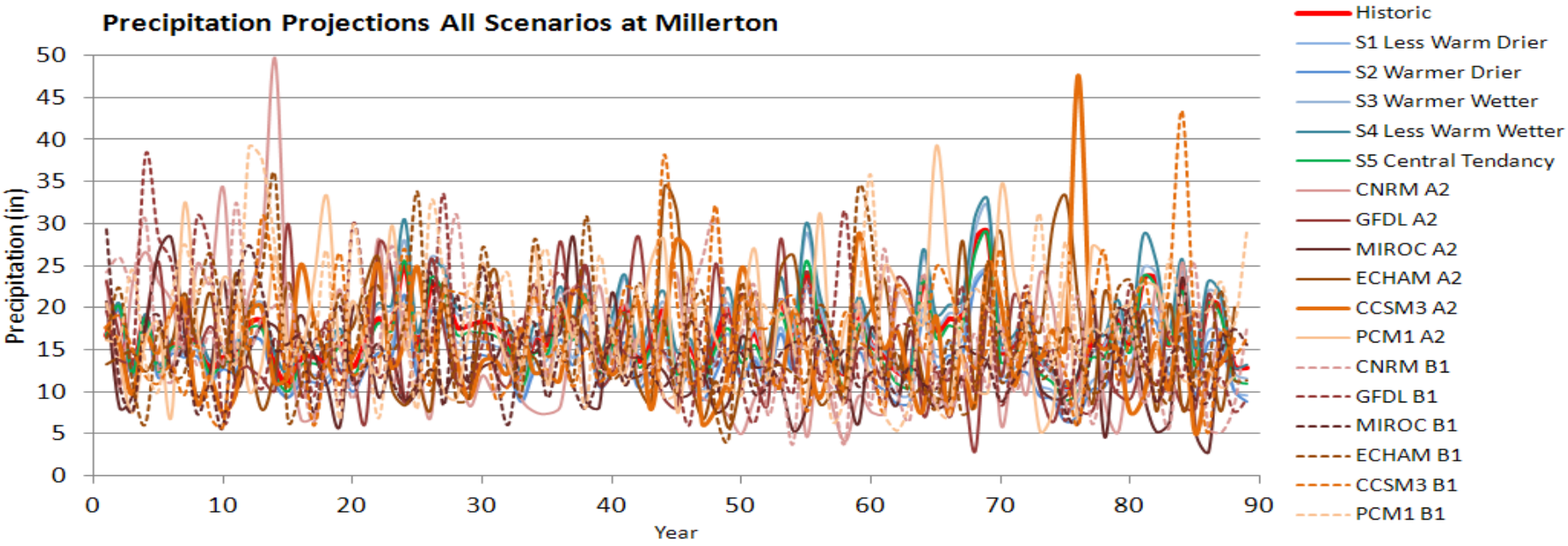

Precipitation Projections All Scenarios at Fresno
Precipitation (in)
Year
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

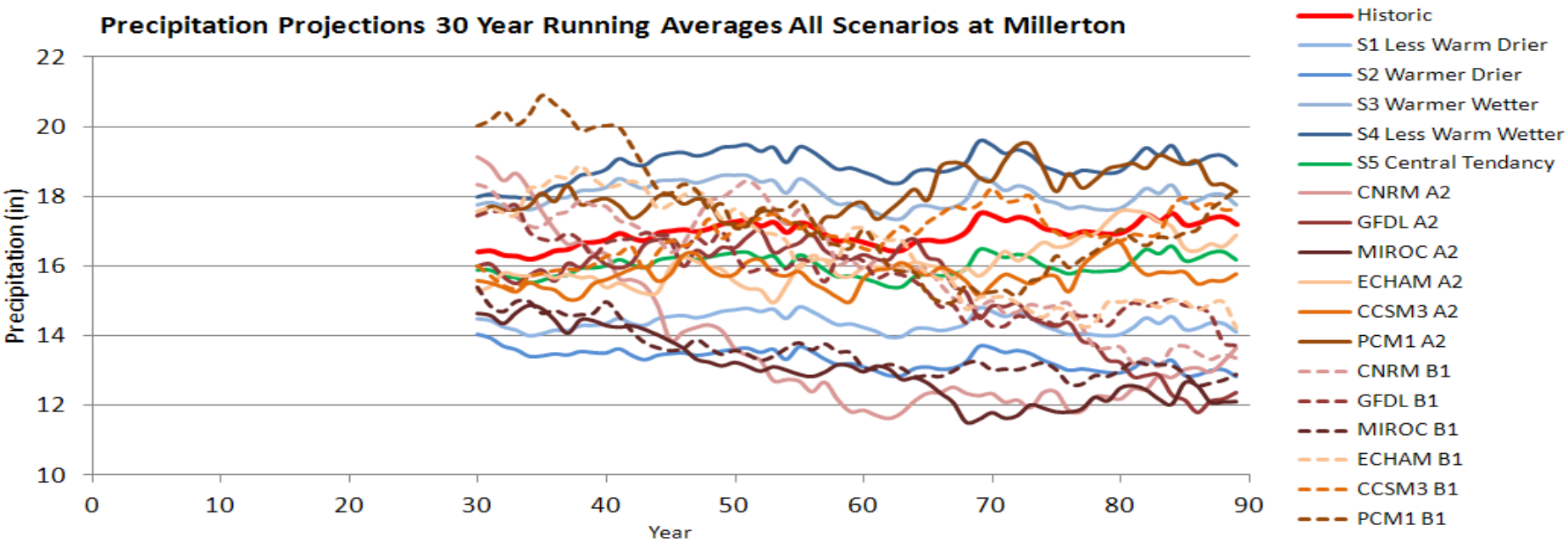

Precipitation Projections 30 Year Running Averages All Scenarios at Fresno
Precipitation (in)
Year
6
7
8
9
10
11
12
13
14
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

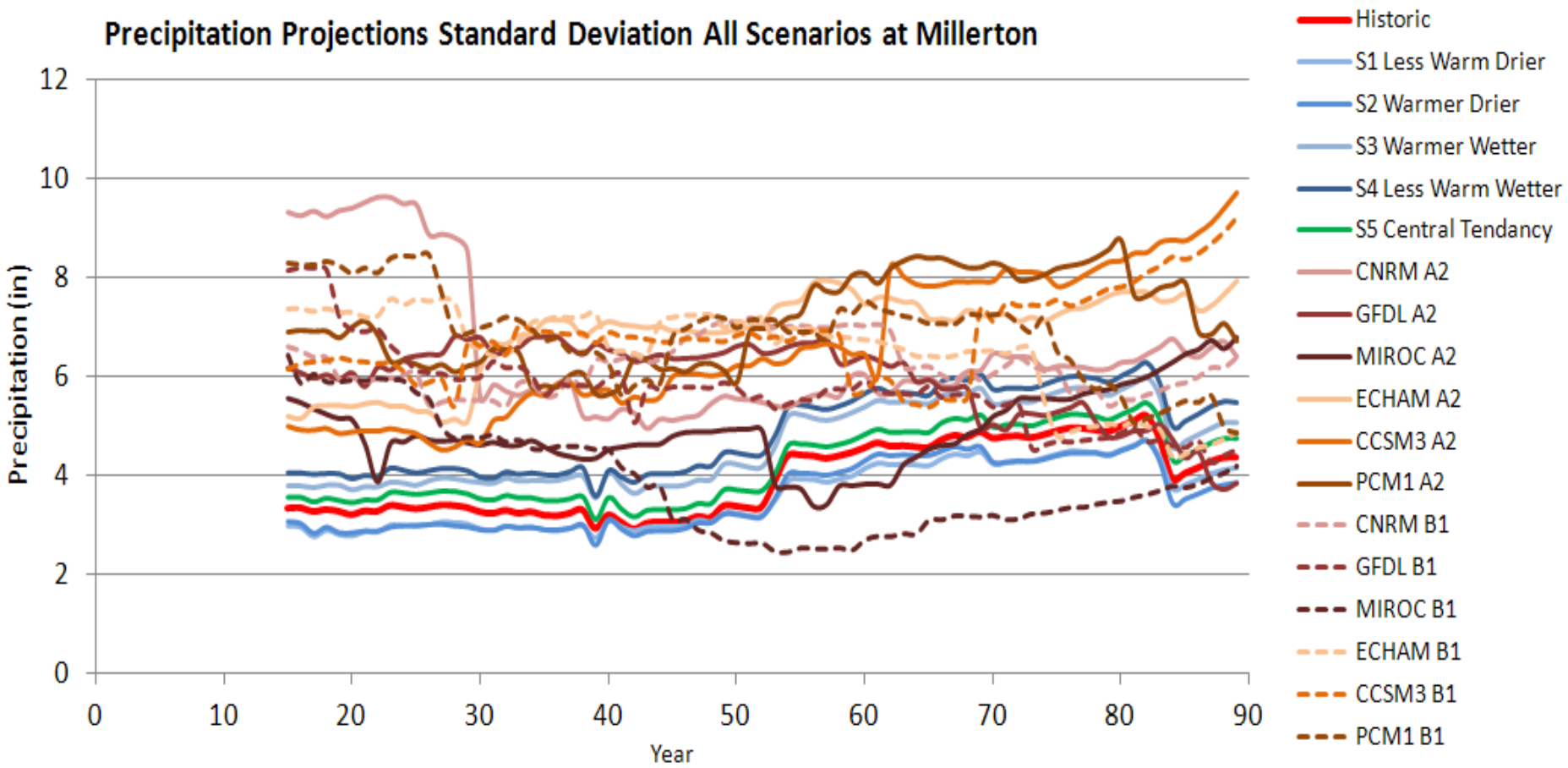

Precipitation Projections Standard Deviation All Scenarios at Fresno
Precipitation (in)
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

Millerton

Precipitation


Precipitation Projections All Scenarios at Millerton
Precipitation (in)
Year
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

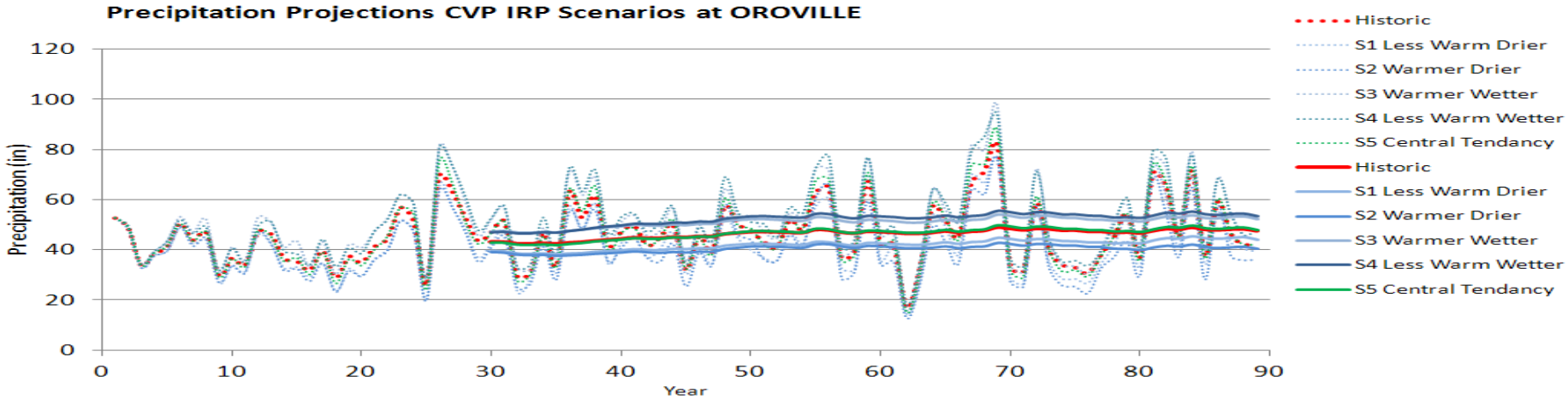

Precipitation Projections 30 Year Running Averages All Scenarios at Millerton
Precipitation (in)
Year
10
12
14
16
18
20
22
0
10
20
30
40
50
60
70
80
90
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

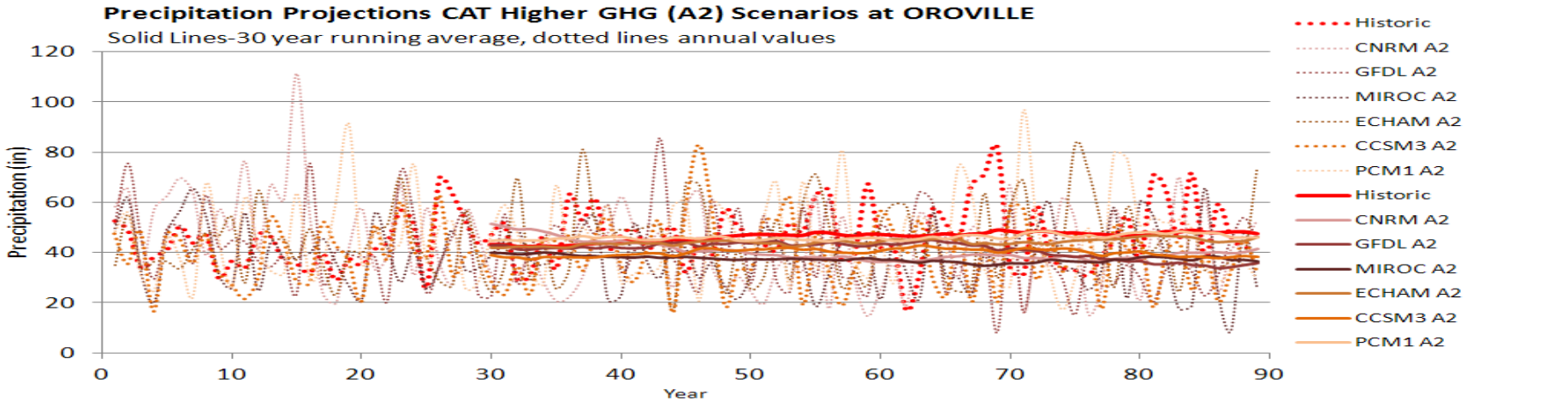

Precipitation Projections Standard Deviation All Scenarios at Millerton
Precipitation (in)
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

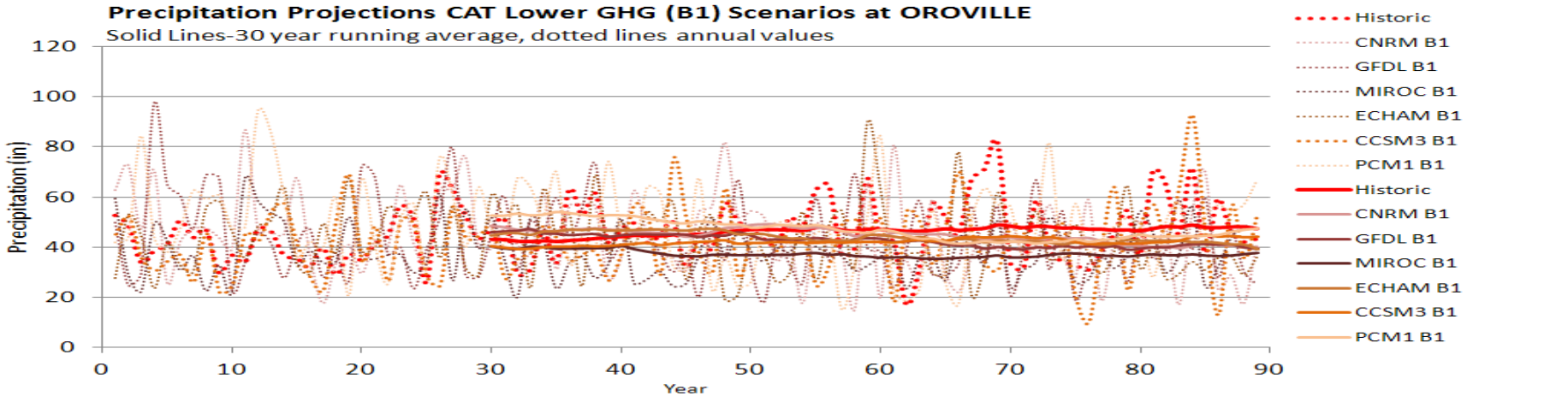
EXTRA SLIDES

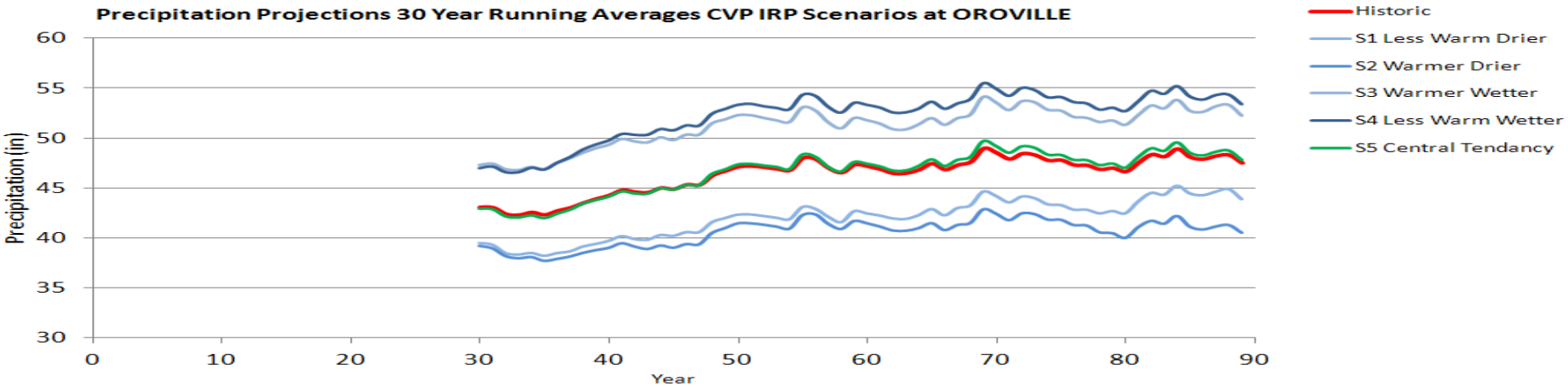
Oroville

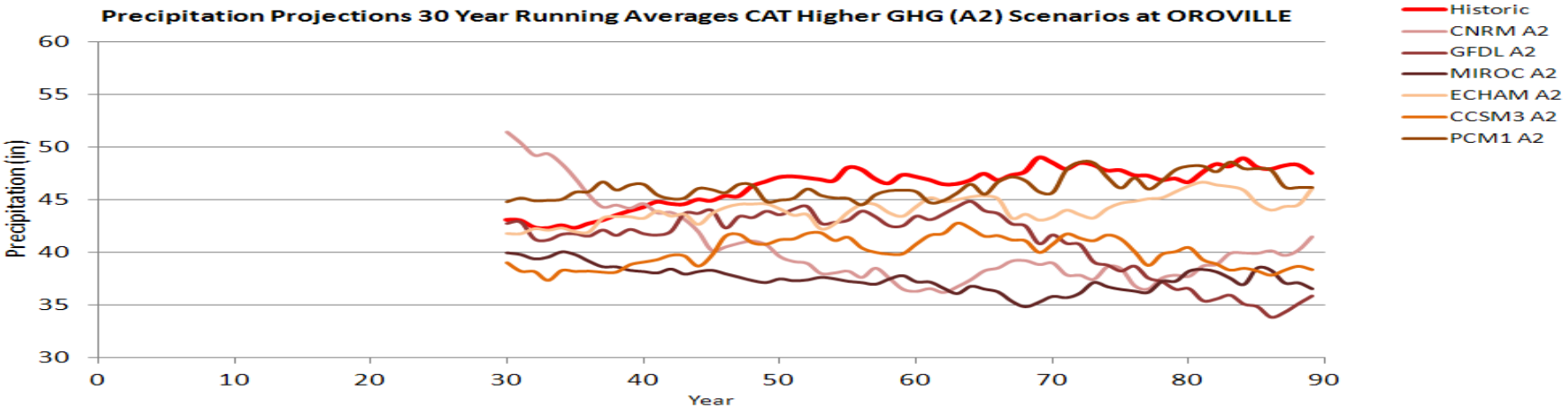
Precipitation

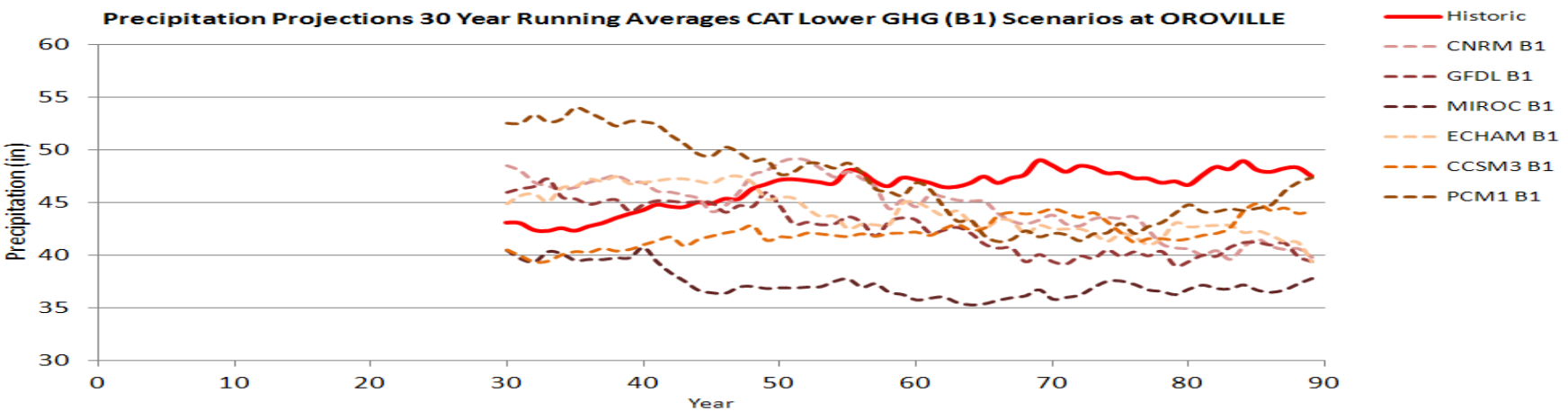

Precipitation Projections CVP IRP Scenarios at OROVILLE
Precipitation (in)
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy

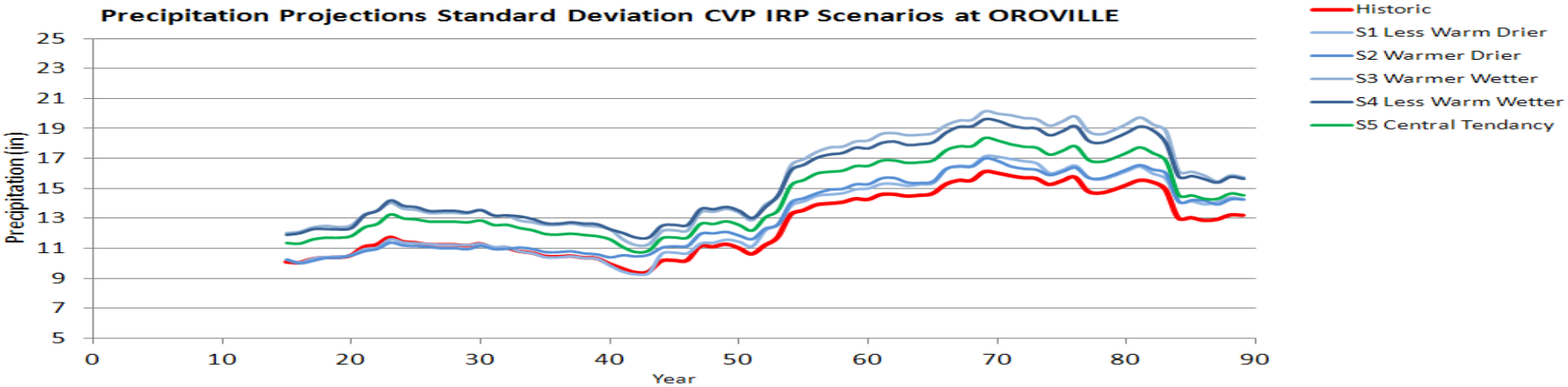

Precipitation Projections CAT Higher GHG (A2) Scenarios at OROVILLE
Solid Lines-30 year running average, dotted lines annual values
Precipitation (in)
Year
Historic
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2
Historic
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2

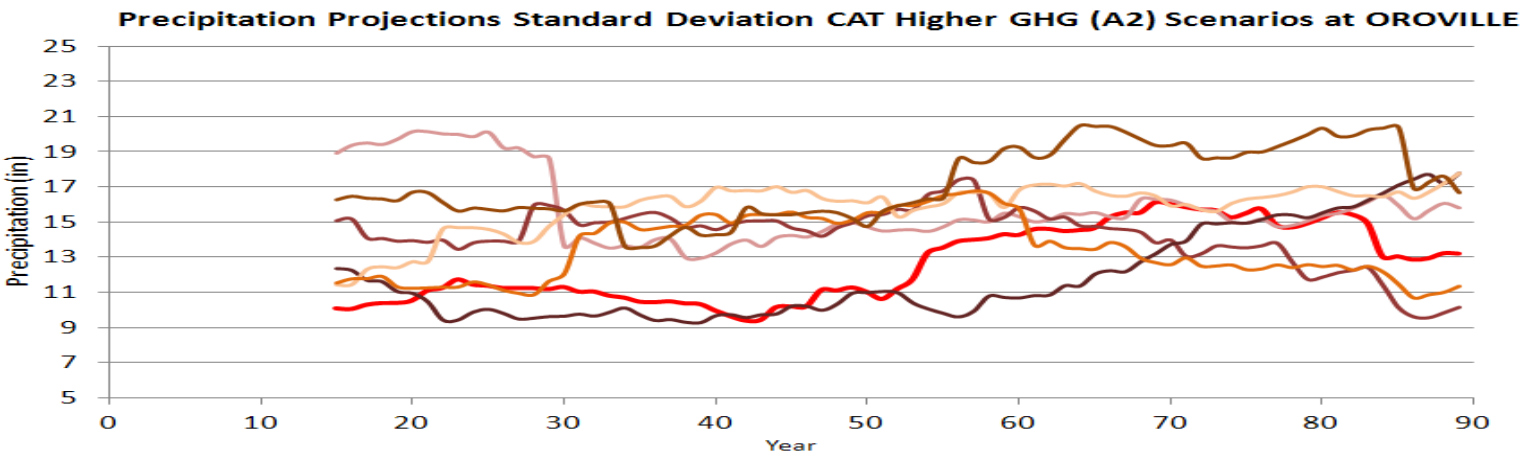

Precipitation Projections CAT Lower GHG (B1) Scenarios at OROVILLE
Solid Lines-30 year running average, dotted lines annual values
Precipitation (in)
Year
Historic
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1
Historic
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

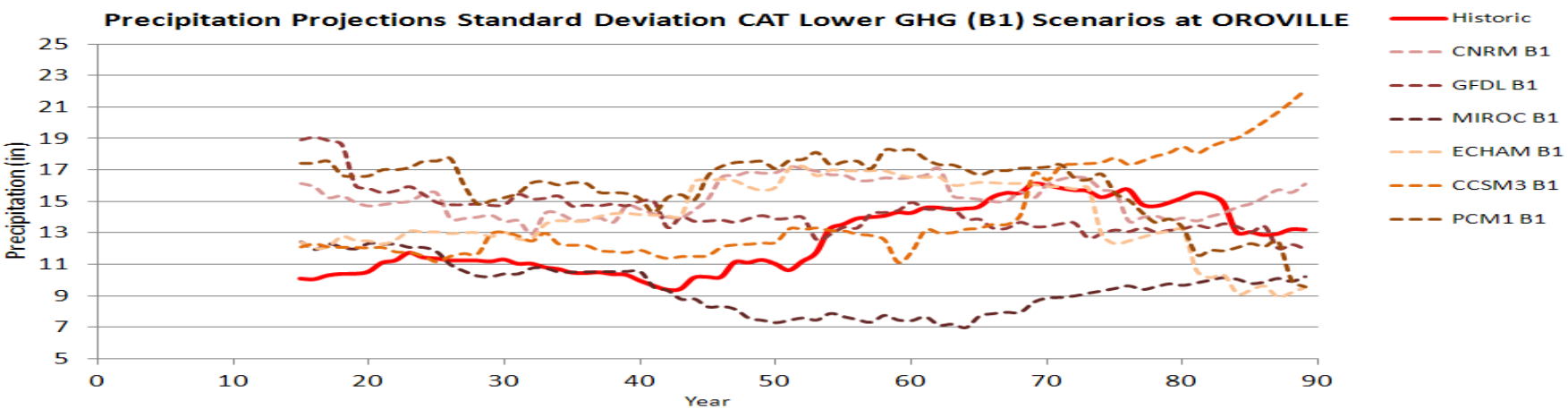

Precipitation Projections 30 Year Running Averages CVP IRP Scenarios at OROVILLE
Precipitation (in)
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy


Precipitation Projections 30 Year Running Averages CAT Higher GHG (A2) Scenarios at OROVILLE
Precipitation (in)
Year
Historic
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2


Precipitation Projections 30 Year Running Averages CAT Lower GHG (B1) Scenarios at OROVILLE
Precipitation (in)
Year
Historic
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1


Precipitation Projections Standard Deviation CVP IRP Scenarios at OROVILLE
Precipitation (in)
Year
Historic
S1 Less Warm Drier
S2 Warmer Drier
S3 Warmer Wetter
S4 Less Warm Wetter
S5 Central Tendancy


Precipitation Projections Standard Deviation CAT Higher GHG (A2) Scenarios at OROVILLE
Precipitation (in)
Year
Historic
CNRM A2
GFDL A2
MIROC A2
ECHAM A2
CCSM3 A2
PCM1 A2


Precipitation Projections Standard Deviation CAT Lower GHG (B1) Scenarios at OROVILLE
Precipitation (in)
Year
Historic
CNRM B1
GFDL B1
MIROC B1
ECHAM B1
CCSM3 B1
PCM1 B1

Red Bluff

Precipitation

Fresno

Precipitation

Millerton

Precipitation