Long-Term Lake Fluctuations Related to MFL Assessments

Presented to NTB II (LTPRG)

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Today's Topics:

- Review of MFL Terminology
  - Historic
  - Current
  - Structural Alteration
  - Long-Term
  - P10
  - P50
  - P90
  - Minimum Lake Level
  - High Minimum Lake Level
  - High Guidance Level
- Analysis of Long-Term
- Lake Stage Fluctuation Statistics Used to Set Lake Minimum Levels
  - Perfect World Example
- Tying Climate and Minimum Lake Levels Together

Structural Alteration:

- Change to the conveyance system of the lake that changes the lake stage fluctuation in a measurable manner.

- Usually, but not always, it involves a change to the outlet of the lake.

- Can include downstream alterations that result in tail water effects.

- Can include up stream changes that either increase or decrease flow to the lake.

- We recognize sinkholes during compliance evaluation, but usually don’t set the level based on them.

Historic

1. Period with no measurable groundwater or withdrawal impacts

2. Structural conditions same as now

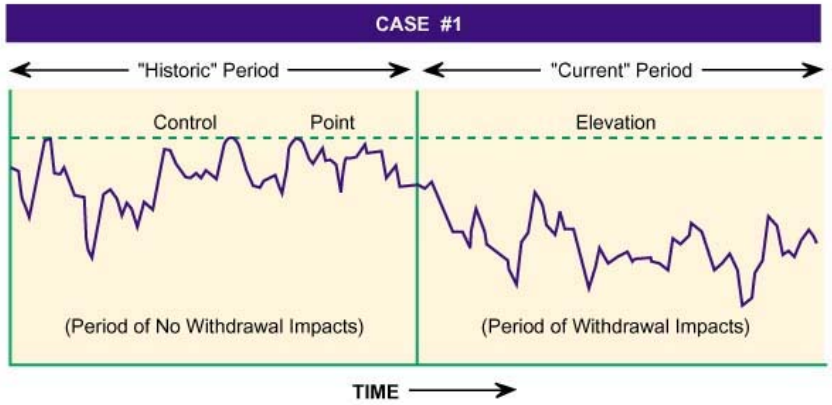
4. No Augmentation

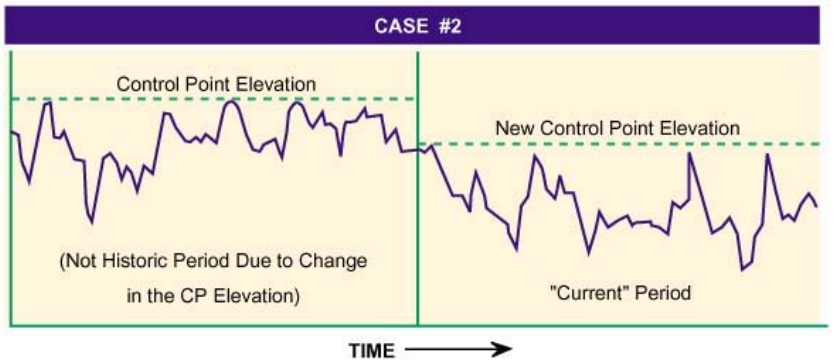
Current

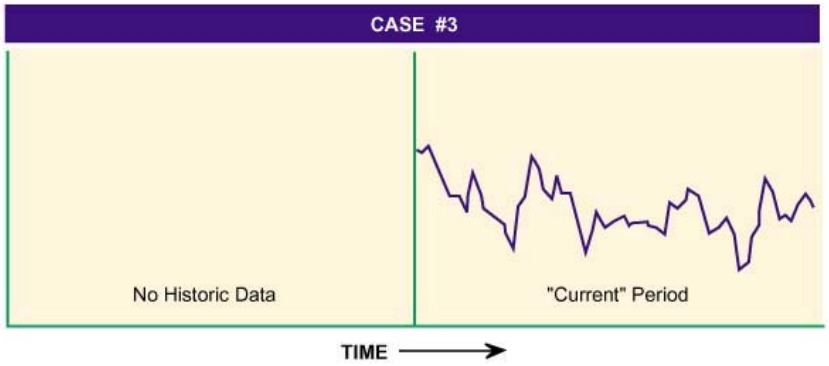
1. No Groundwater or withdrawal impacts

2. Structural conditions same as now

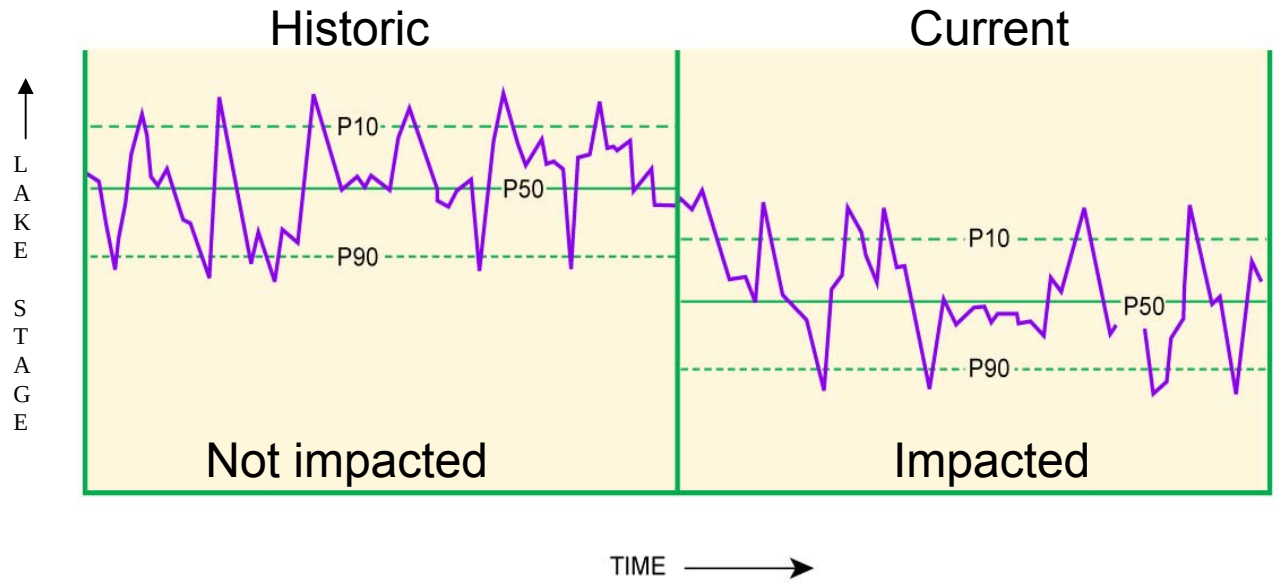
3. No Augmentation







Data limitations encountered that required use of the reference lake water regime of define lake fluctuation absent withdrawal impacts.



P10 = Elevation the lake stage is equal to or above 10% of the time

P50 = Elevation the lake stage is equal to or above 50% of the time

P90 = Elevation the lake stage is equal to or above 90% of the time

Minimum Lake Levels are Long-Term Percentiles

- Minimum Lake level is the Historic P50 minus some offset.

  MLL represents a new P50 value

- High Minimum Lake Level is the Historic P10 minus some offset.

  HMLL represents a new P10 value

- High Guidance Level is the Historic P10 (i.e. no offset)

  HGL = Historic P10

Analysis
Of
“Long Term”

Chapter 40D-8 defines long-term as:

"Long-term means an evaluation period utilized to establish Minimum Flows and Levels, to determine compliance with established Minimum Levels and to assess withdrawal impacts on established Minimum Flows and Levels that represents a period which spans the range of hydrologic conditions which can be expected to occur based upon historical records, ranging from high water levels to low water levels. In the context of a predictive model simulation, a Long-term simulation will be insensitive to temporal fluctuations in withdrawal rates and hydrologic conditions, so as to simulate steady-state average conditions. In the context of an average water level, the average will be based upon the historic expected range and frequency of levels. Relative to Minimum Flow establishment and Minimum Level establishment and compliance, where there are six years or more of competent data, a minimum of a six-year evaluation period will be used, but available data and reasonable scientific judgment will dictate whether a longer period is used. Where there are less than six years of competent data, the period used will be dictated by the available data and a determination, based on reasonable scientific judgment, that the period is sufficiently representative of Long-term conditions"

Long-Term is at Least 60 + Years

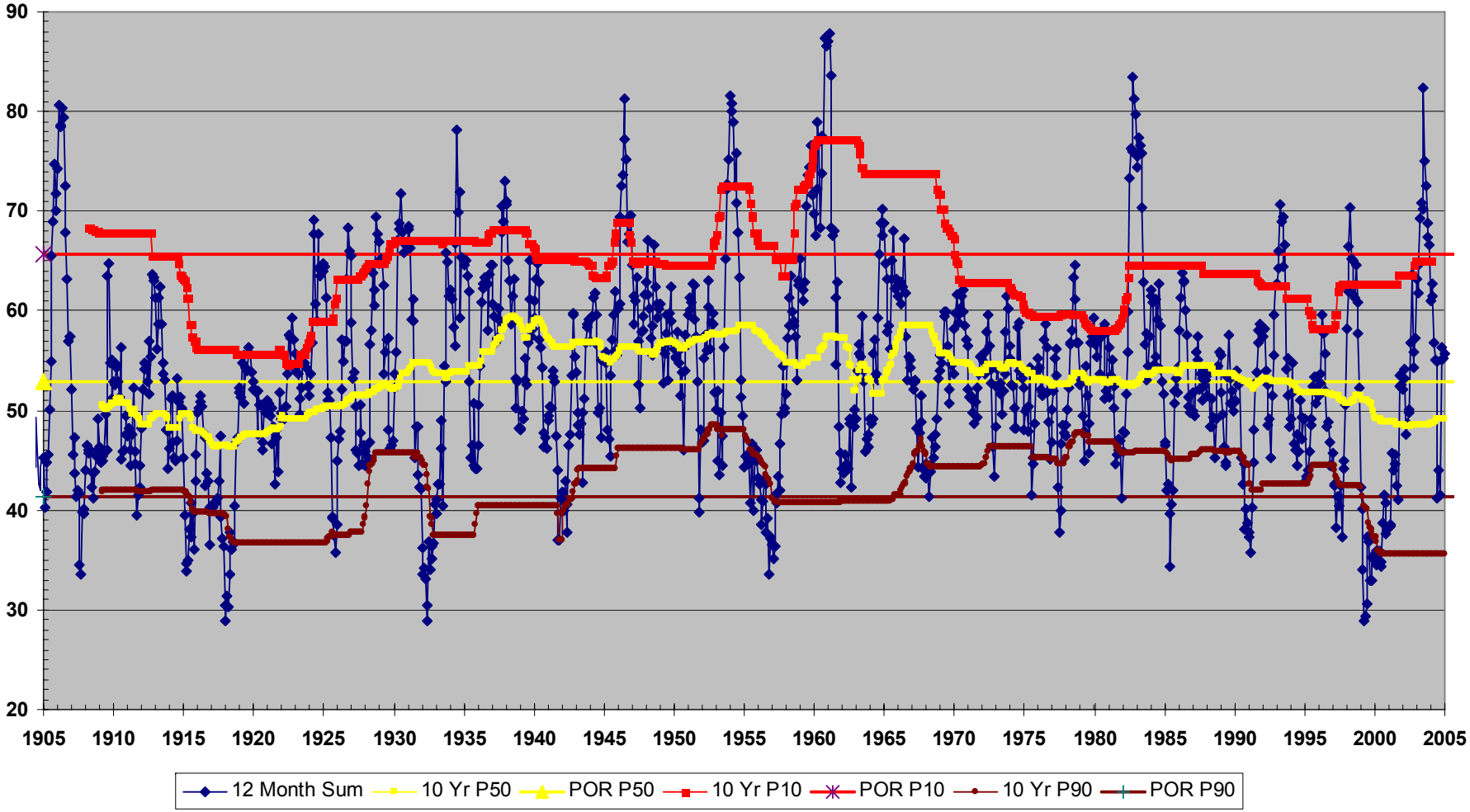
(Actually there are cycles in cycles, that will keep producing new values but we are setting a limit at 60 to 100 years)

Fact:

1. Percentiles calculated with shorter windows of time will cycle above and below the longer term percentile.

2. The shorter the window of time the larger the variation around the long-term.

Inverness


90
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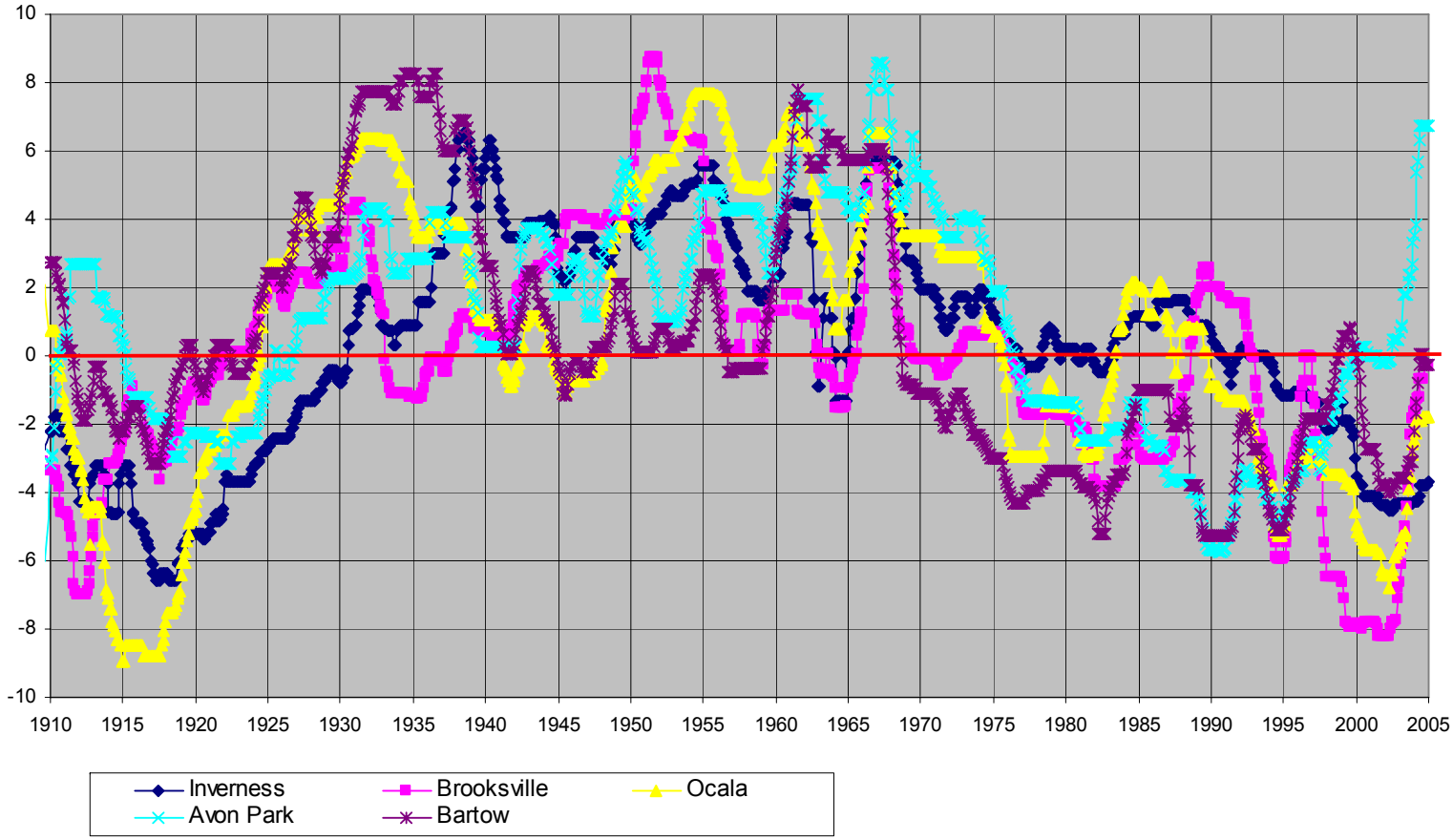
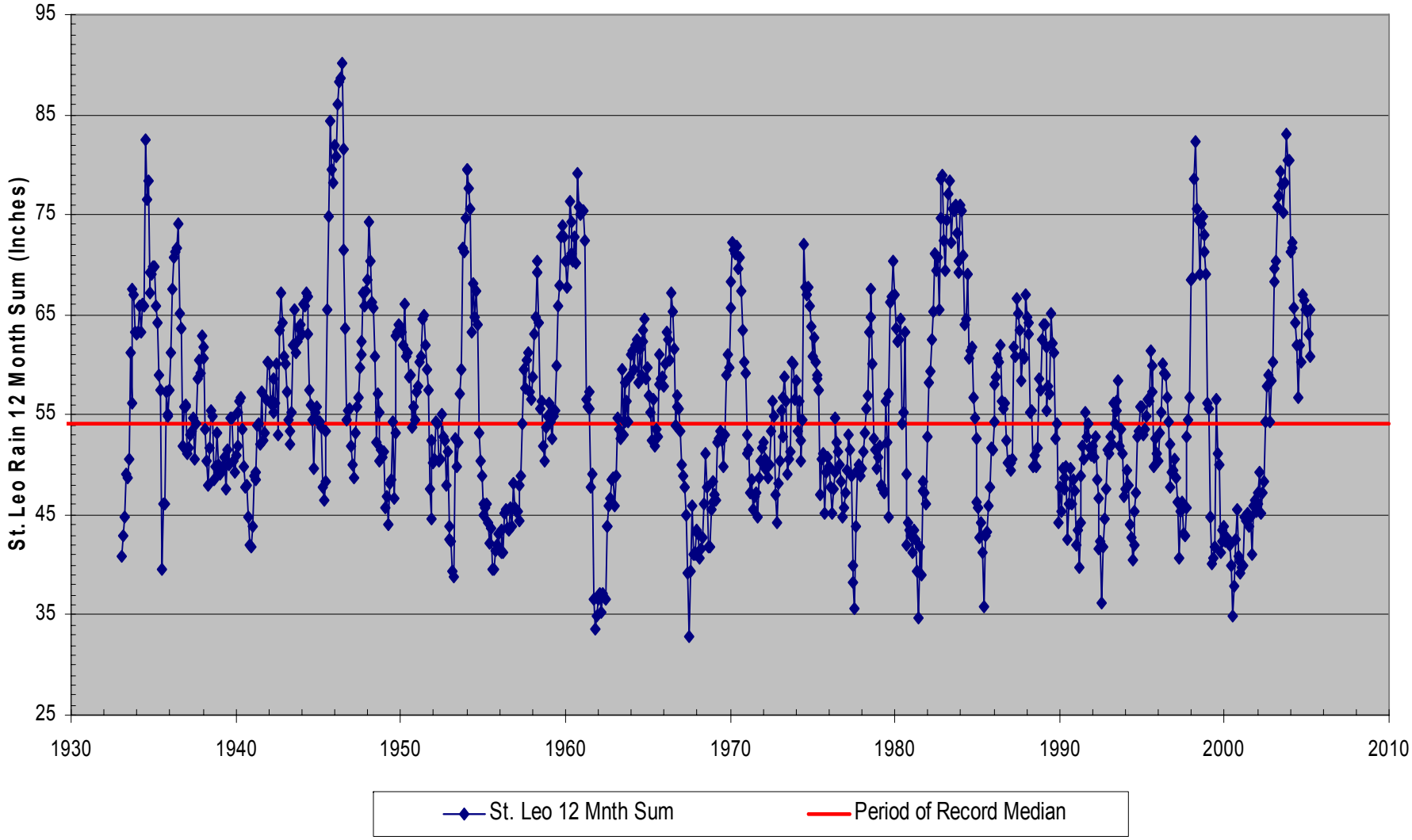
1990
1995
2000
2005
12 Month Sum
10 Yr P50
POR P50
10 Yr P10
POR P10
10 Yr P90
POR P90

Rainfall 10-yr Moving Median Minus the POR Median

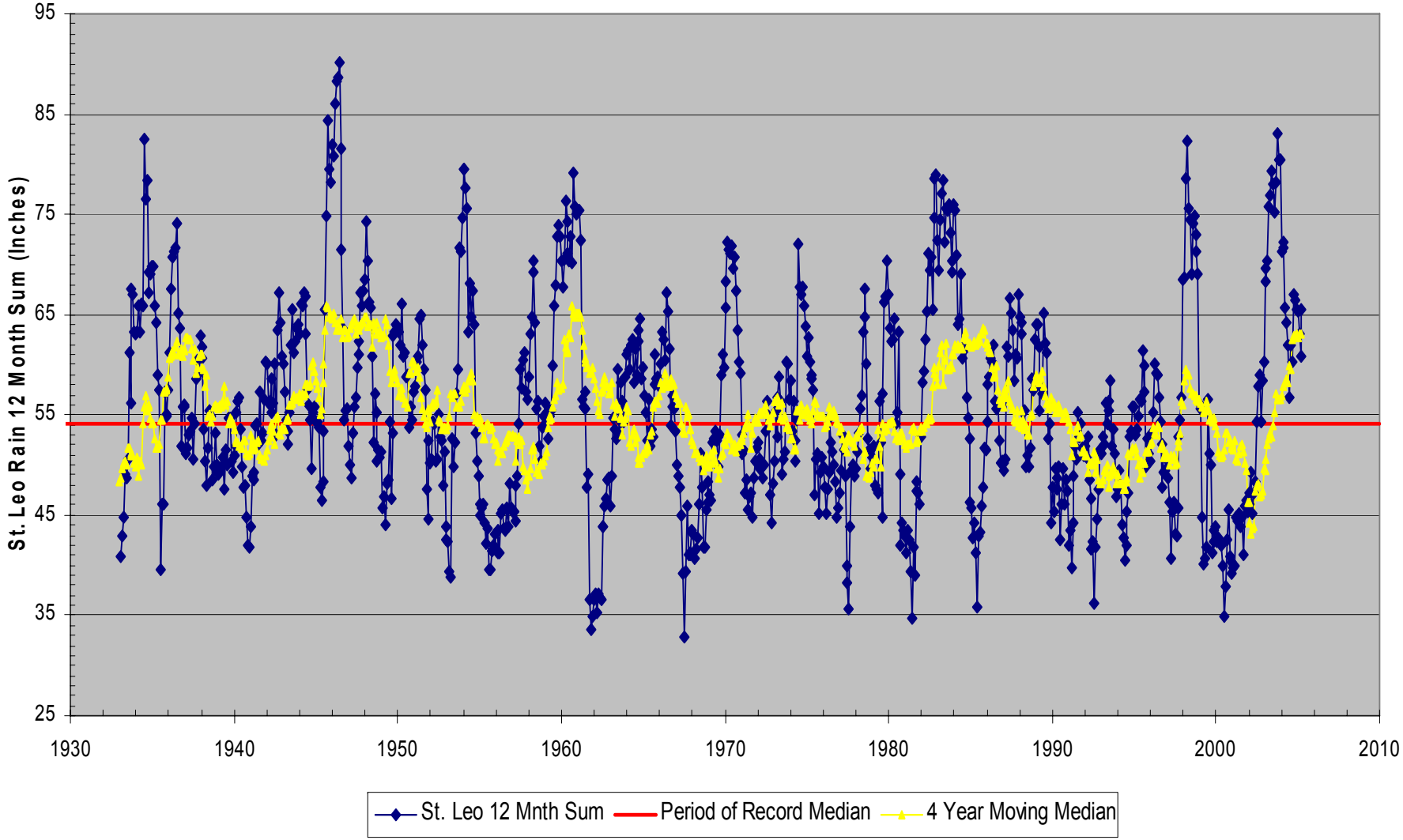


St. Leo Rain

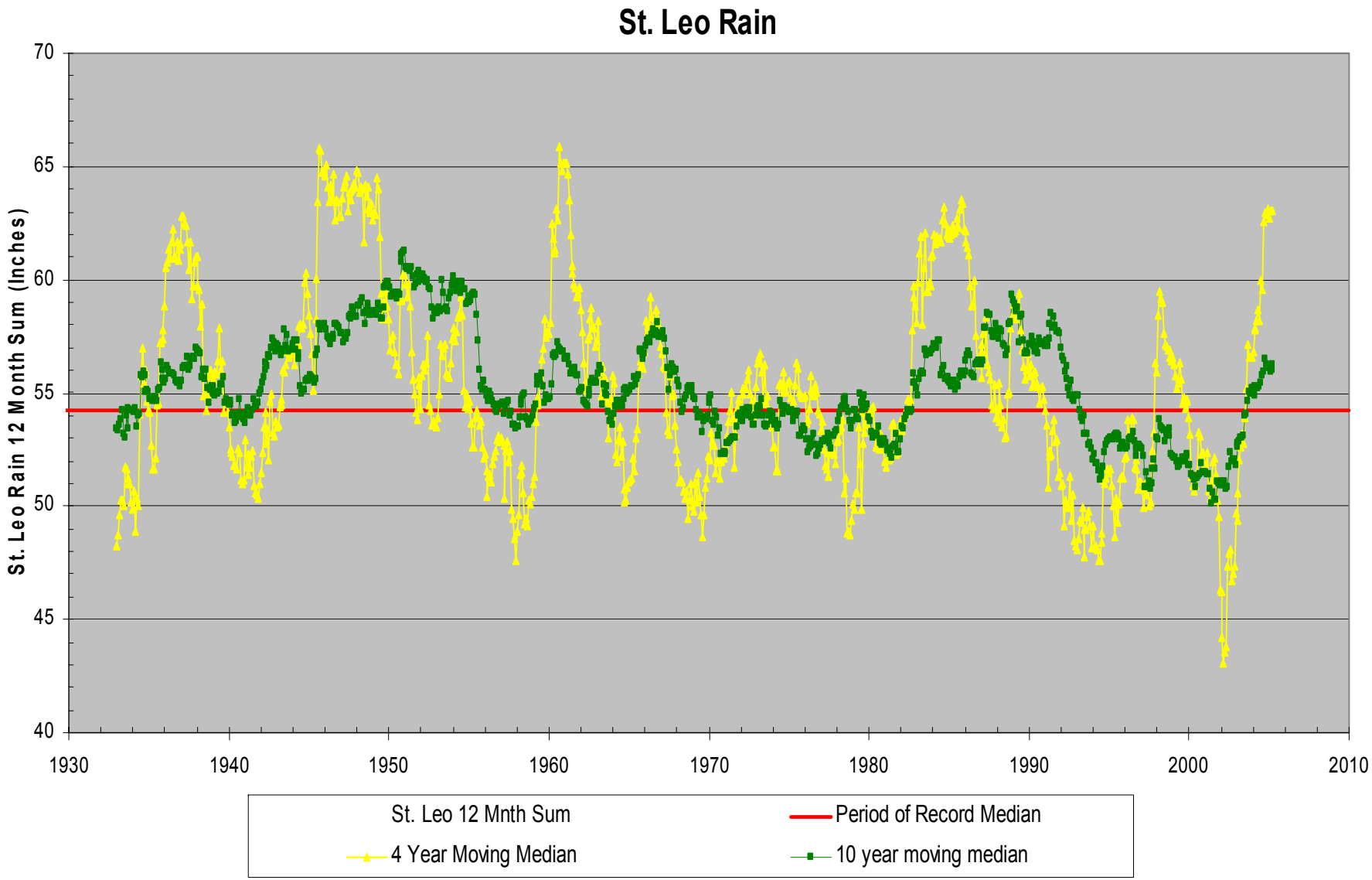


D.L.E. August 21, 2006

St. Leo Rain

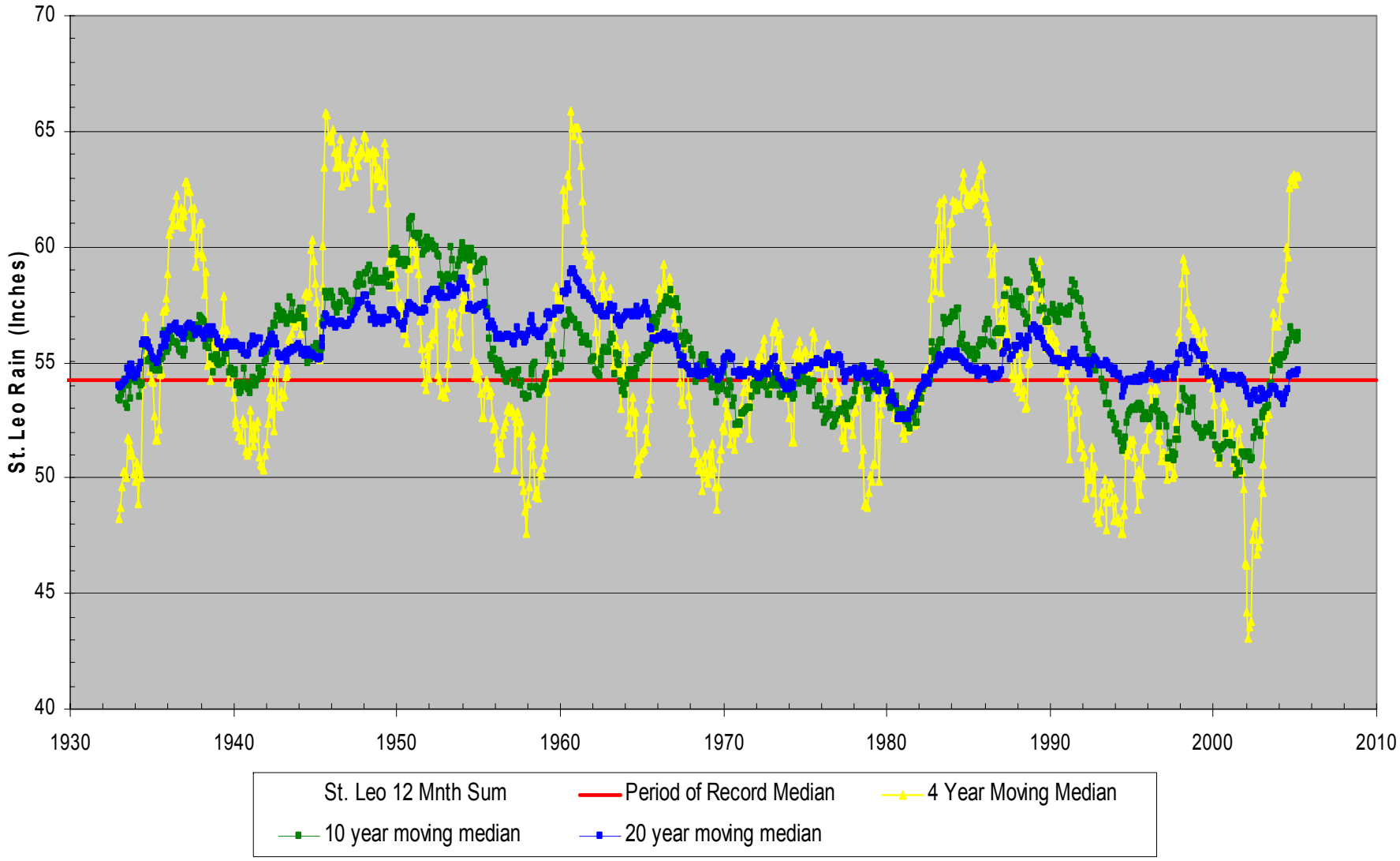


D.L.E. August 21, 2006



D.L.E. August 21, 2006

St. Leo Rain

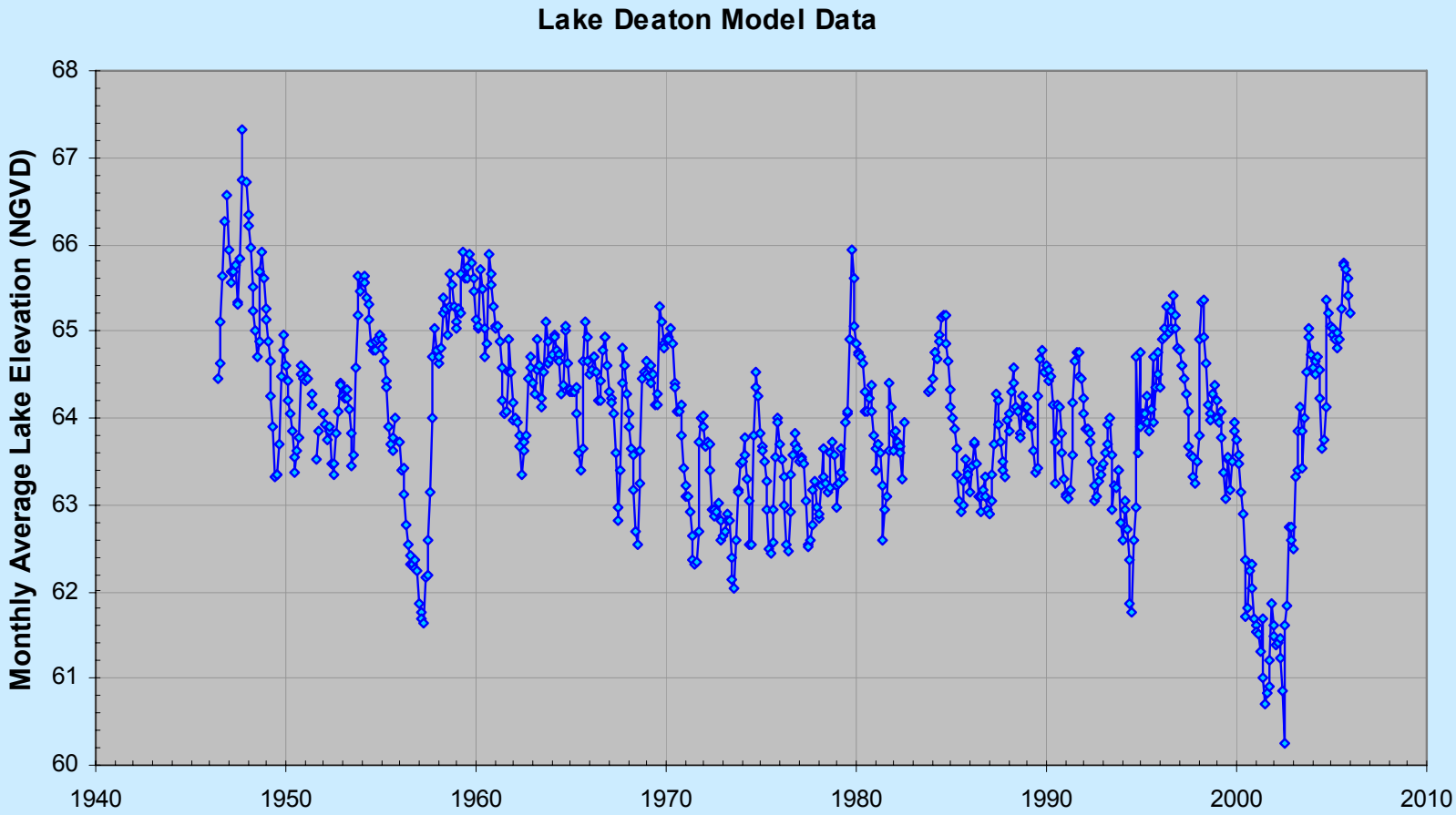


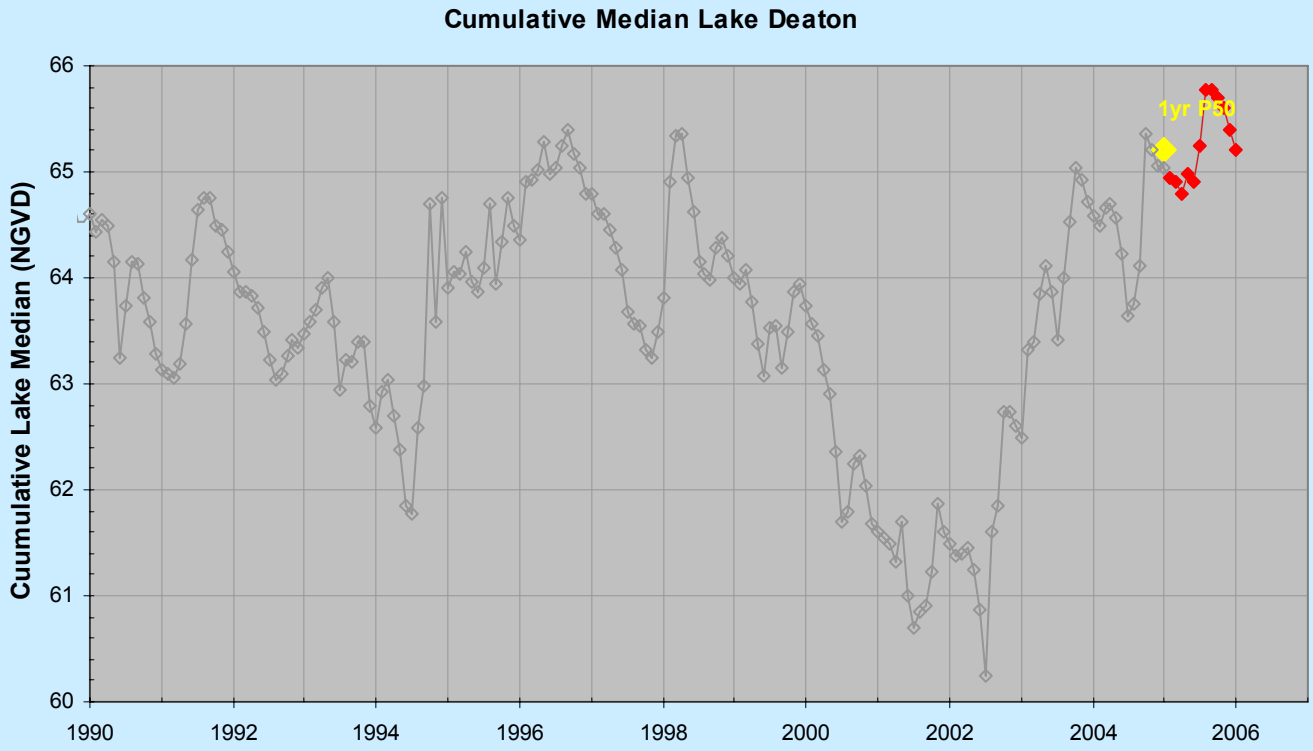
D.L.E. August 21, 2006

What is long term?

- One way to answer it is determine how much data is required before adding more data doesn't significantly change the median.

- How much uncertainty can we accept? (+/- 0.5', 0.1' ?)


Lake Deaton Model Data
Monthly Average Lake Elevation (NGVD)
68
67
66
65
64
63
62
61
60
1940
1950
1960
1970
1980
1990
2000
2010


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
66
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64
63
62
61
60
1990
1992
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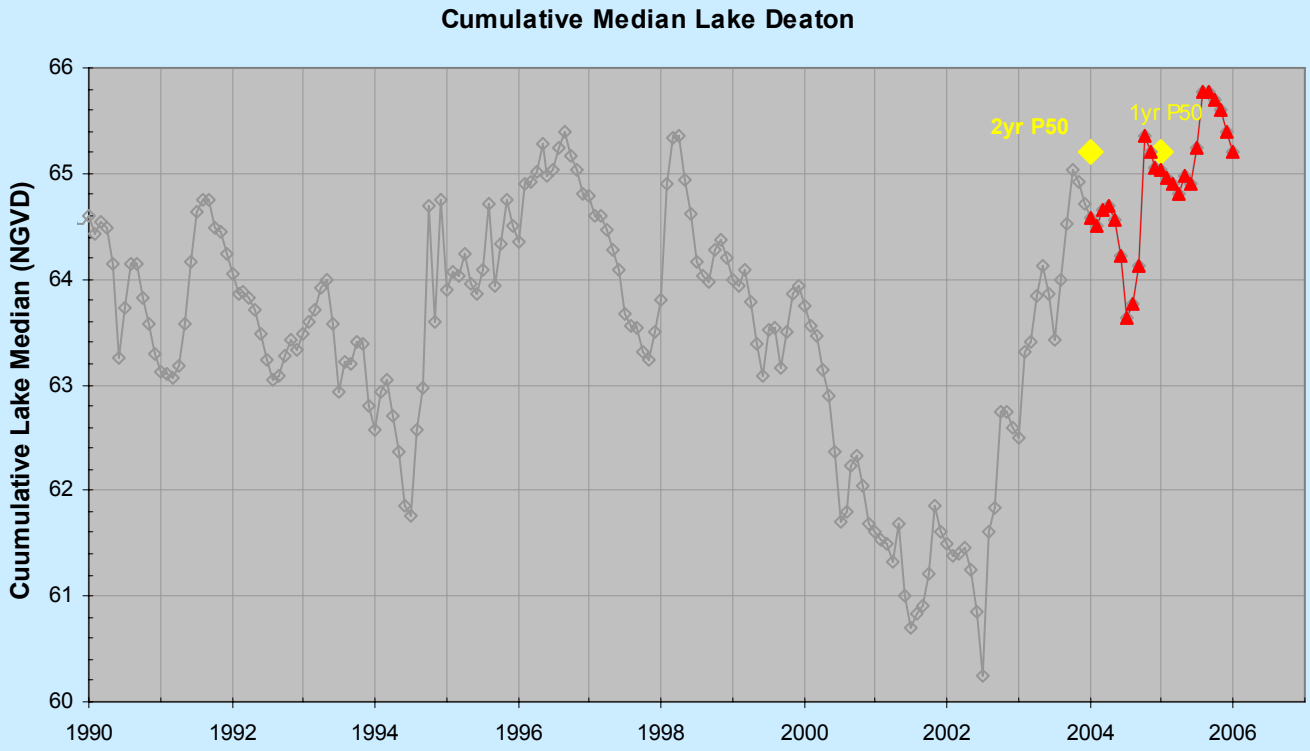
1996
1998
2000
2002
2004
2006
1yr P50


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
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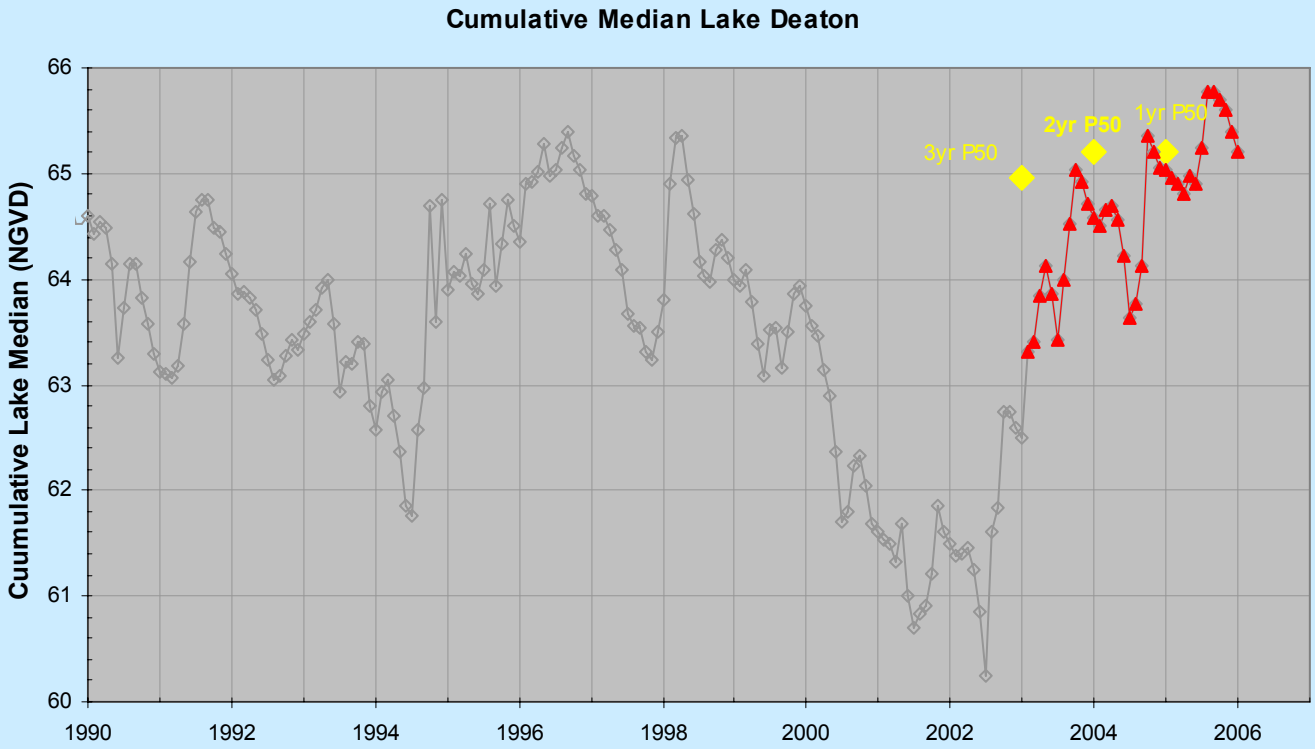
2002
2004
2006
2yr P50
1yr P50


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
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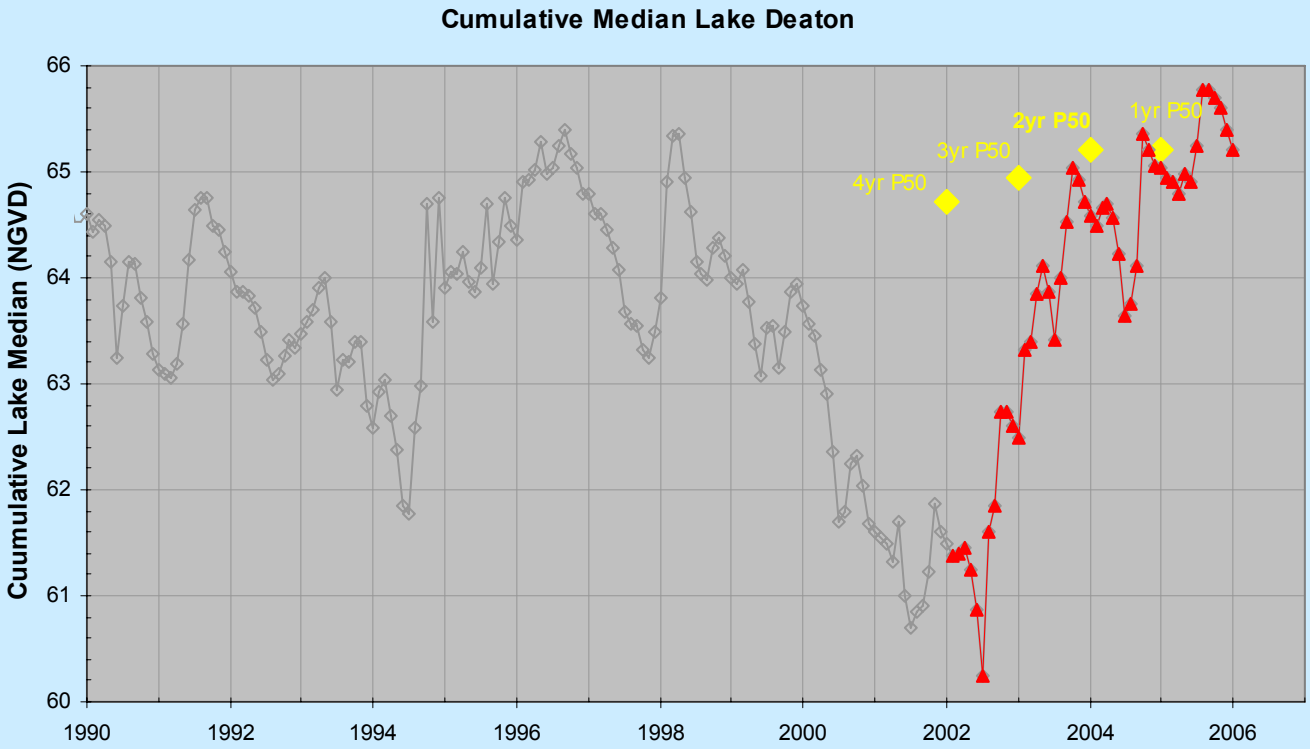
2004
2006
3yr P50
2yr P50
1yr P50


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
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62
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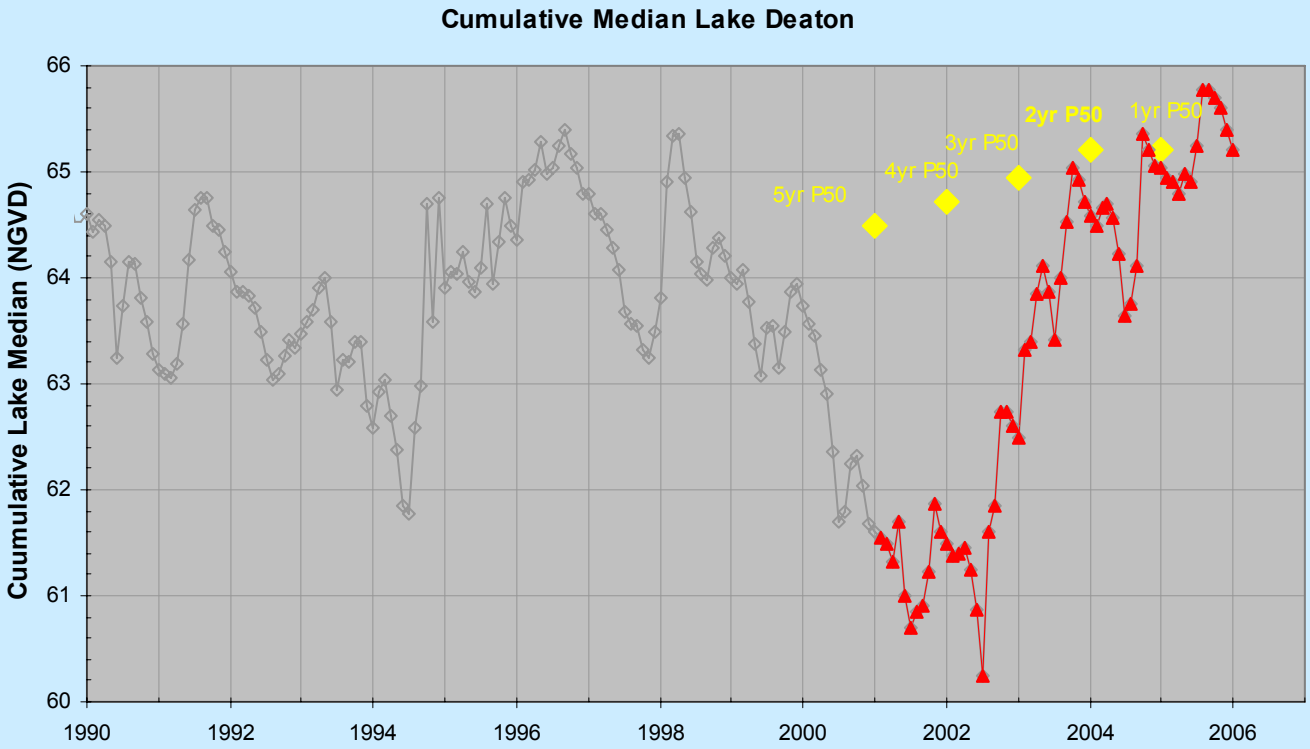
2004
2006
4yr P50
3yr P50
2yr P50
1yr P50


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
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63
62
61
60
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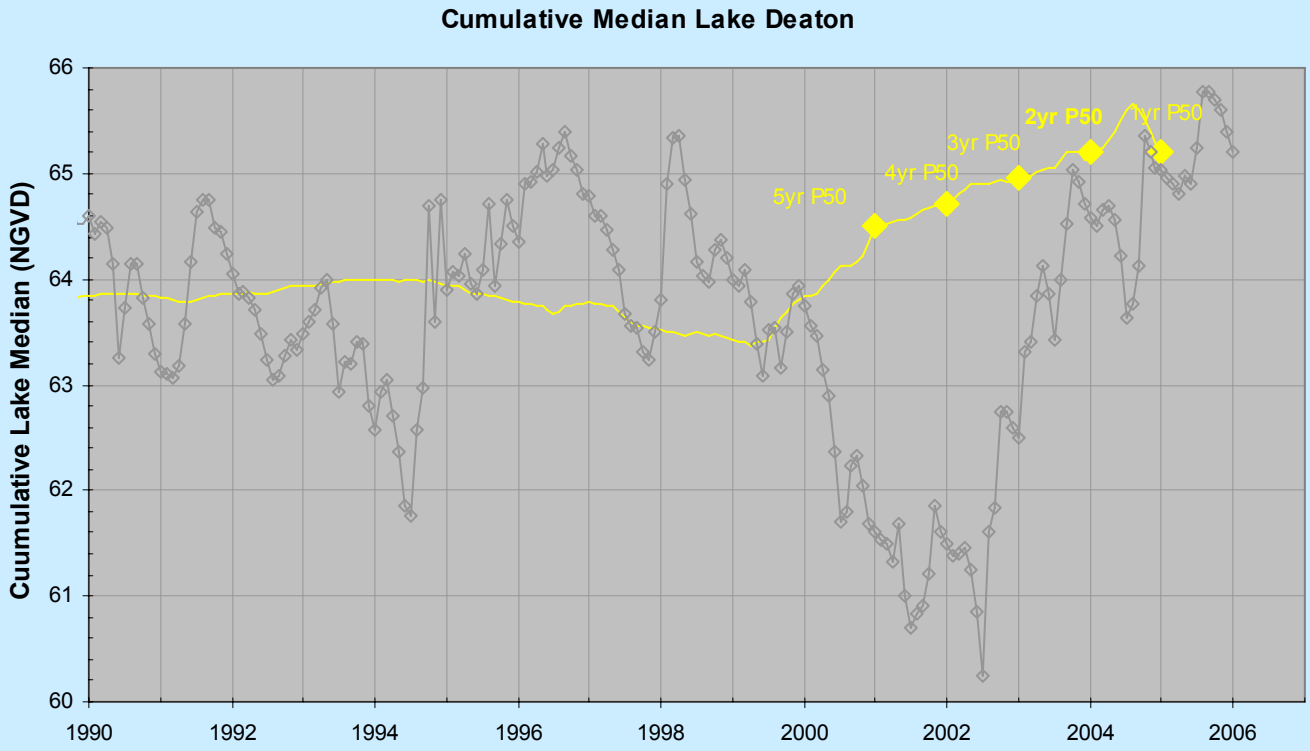
2002
2004
2006
5yr P50
4yr P50
3yr P50
2yr P50
1yr P50


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
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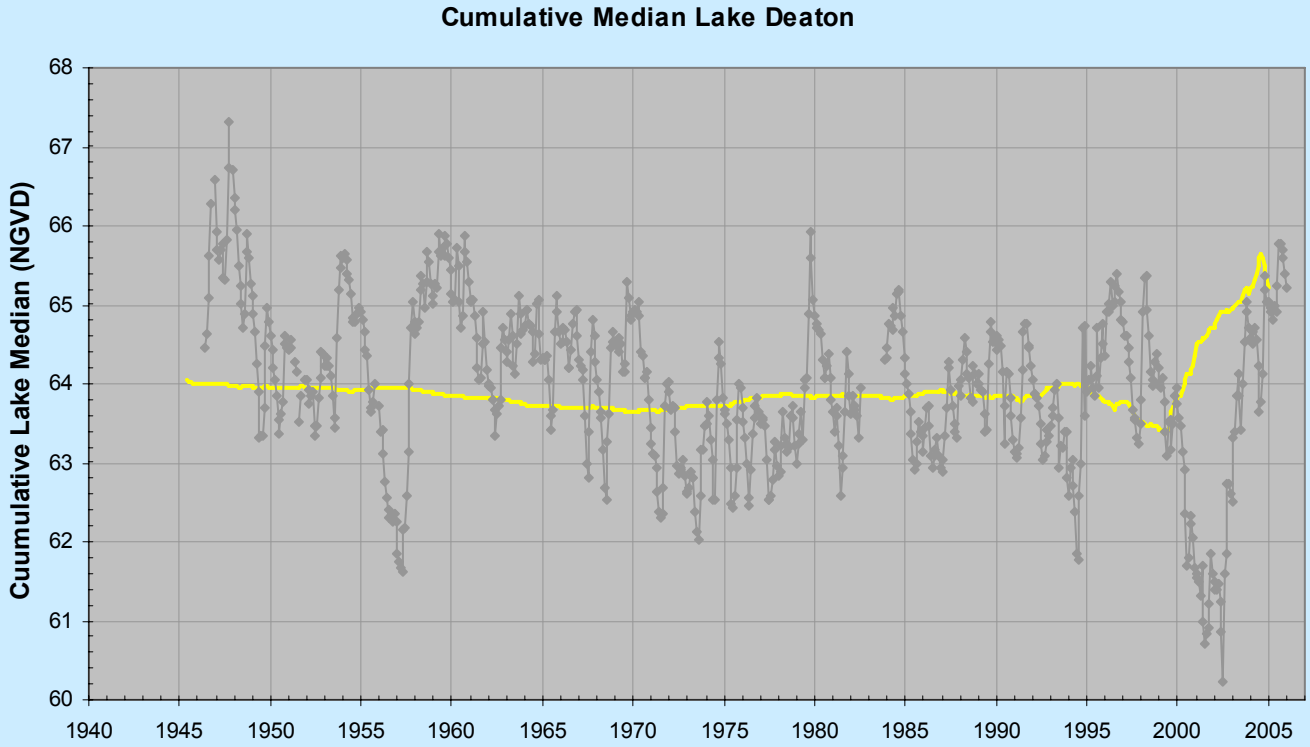
2004
2006
5yr P50
4yr P50
3yr P50
2yr P50
1yr P50


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
68
67
66
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64
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62
61
60
1940
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1955
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1965
1970
1975
1980
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1995
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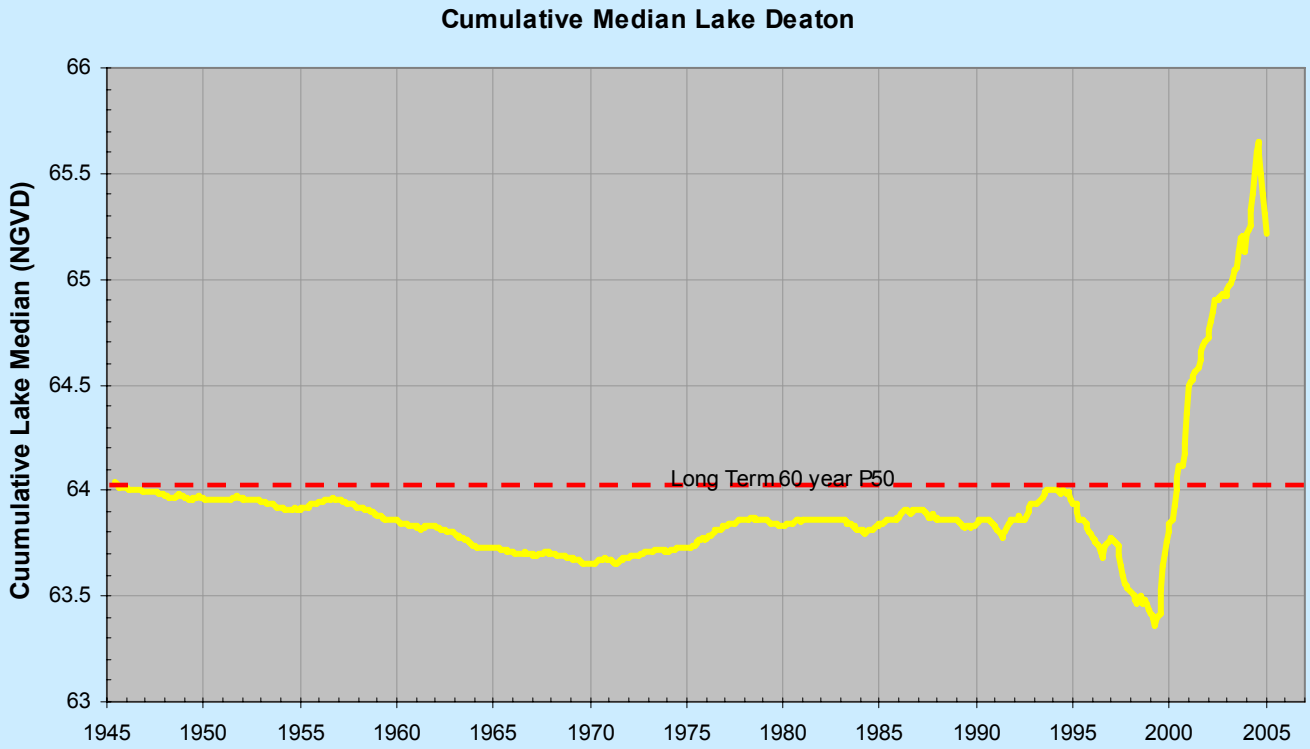
2005


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
66
65.5
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64.5
64
63.5
63
1945
1950
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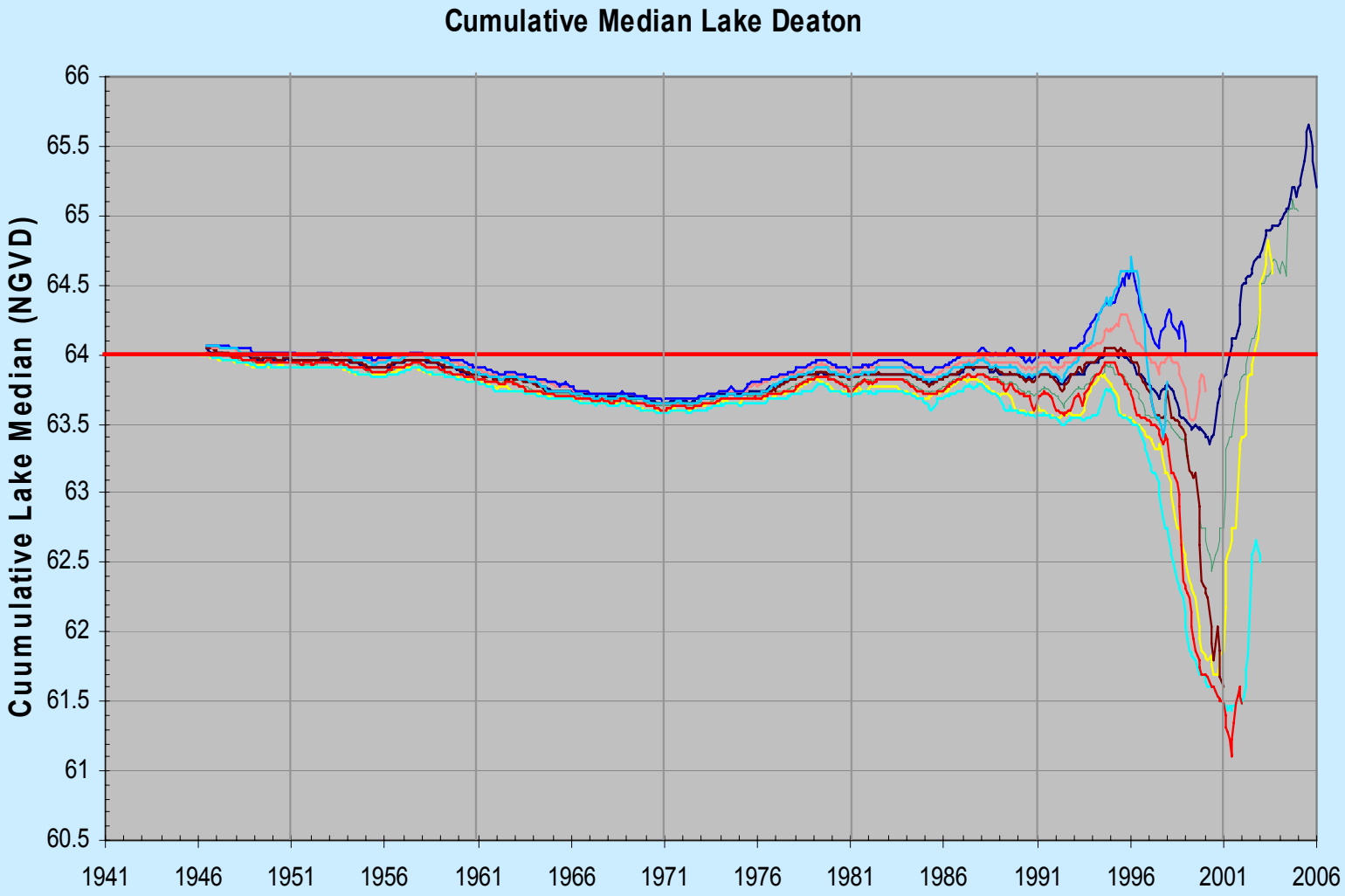
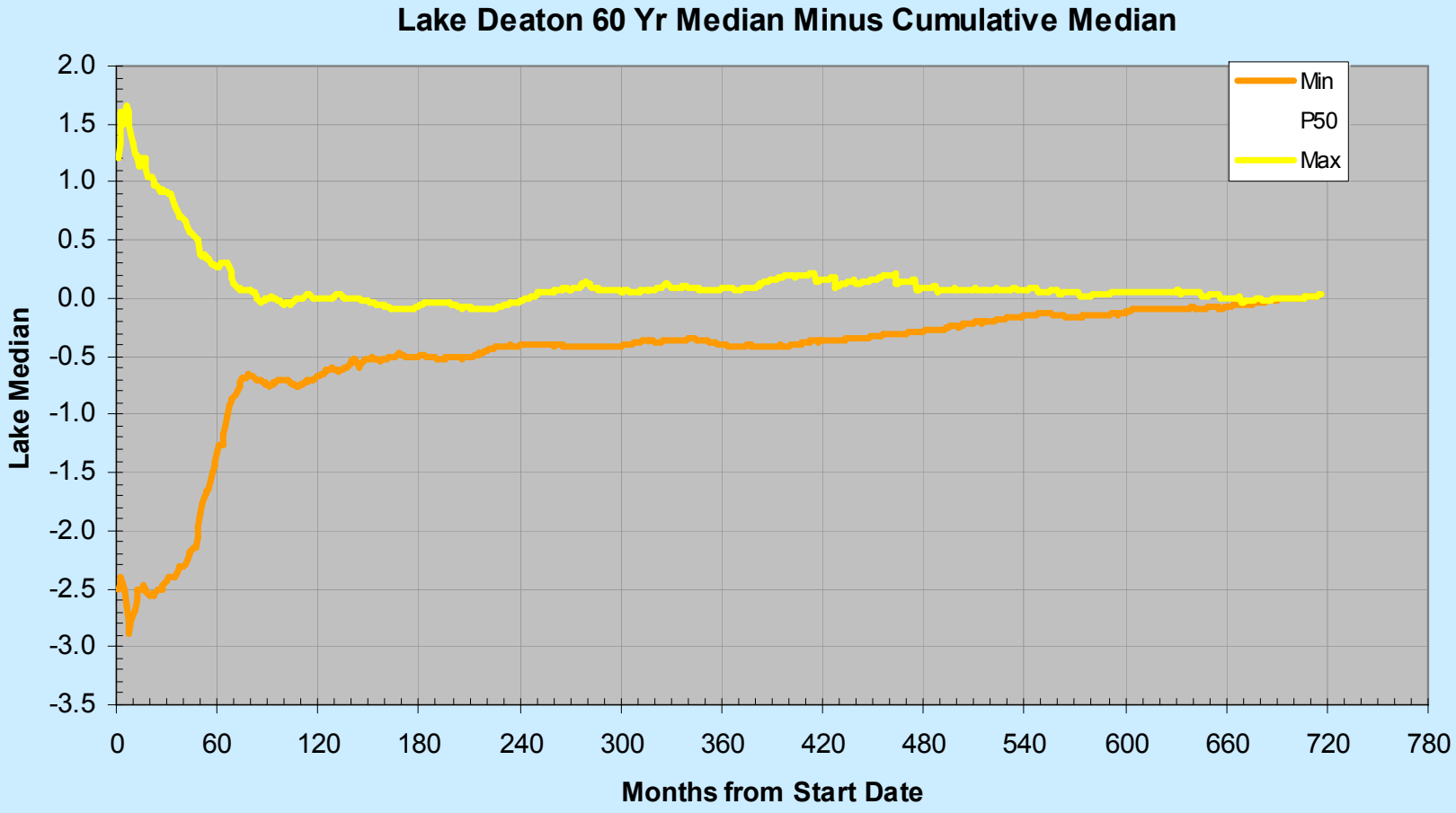
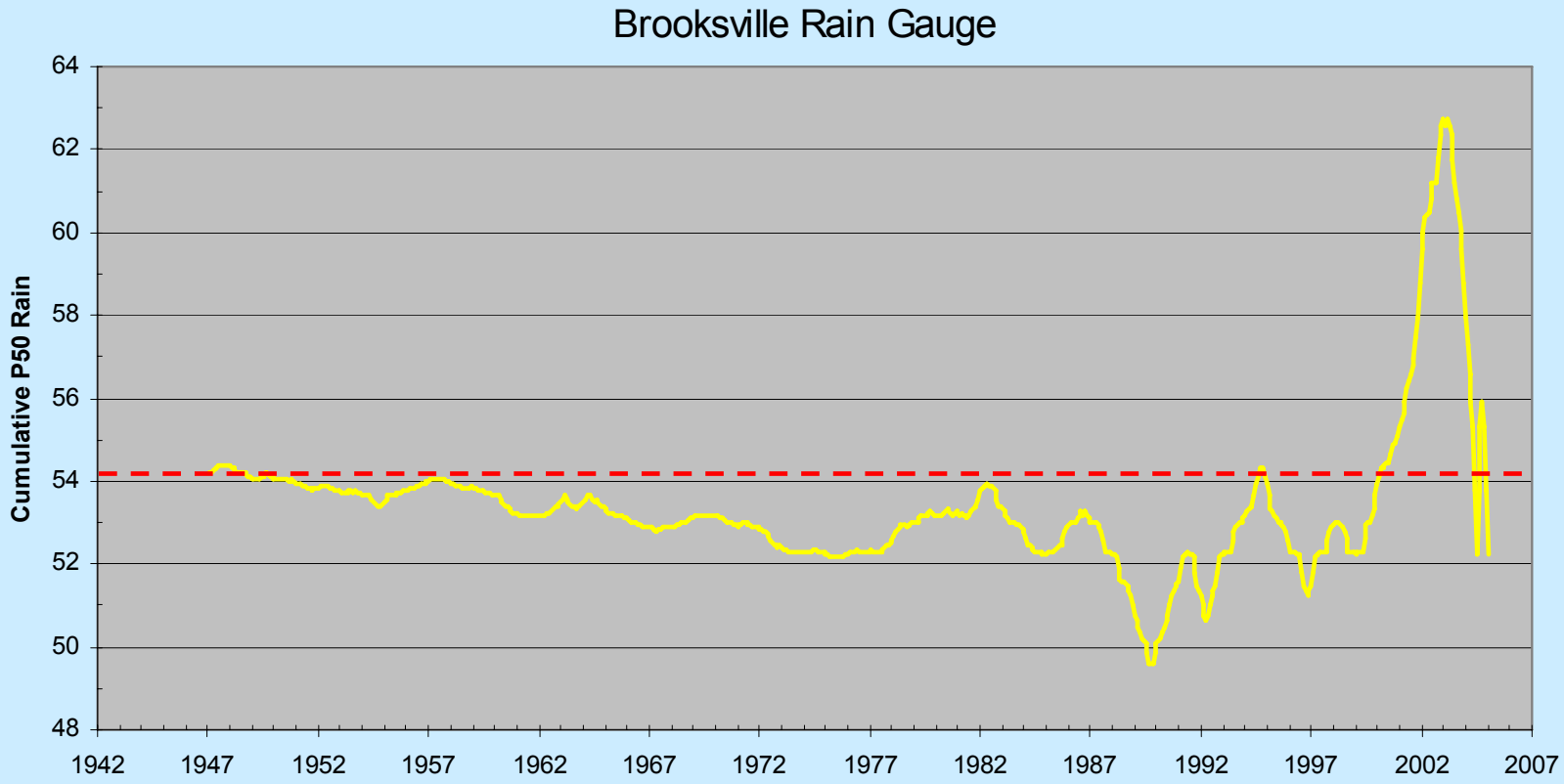
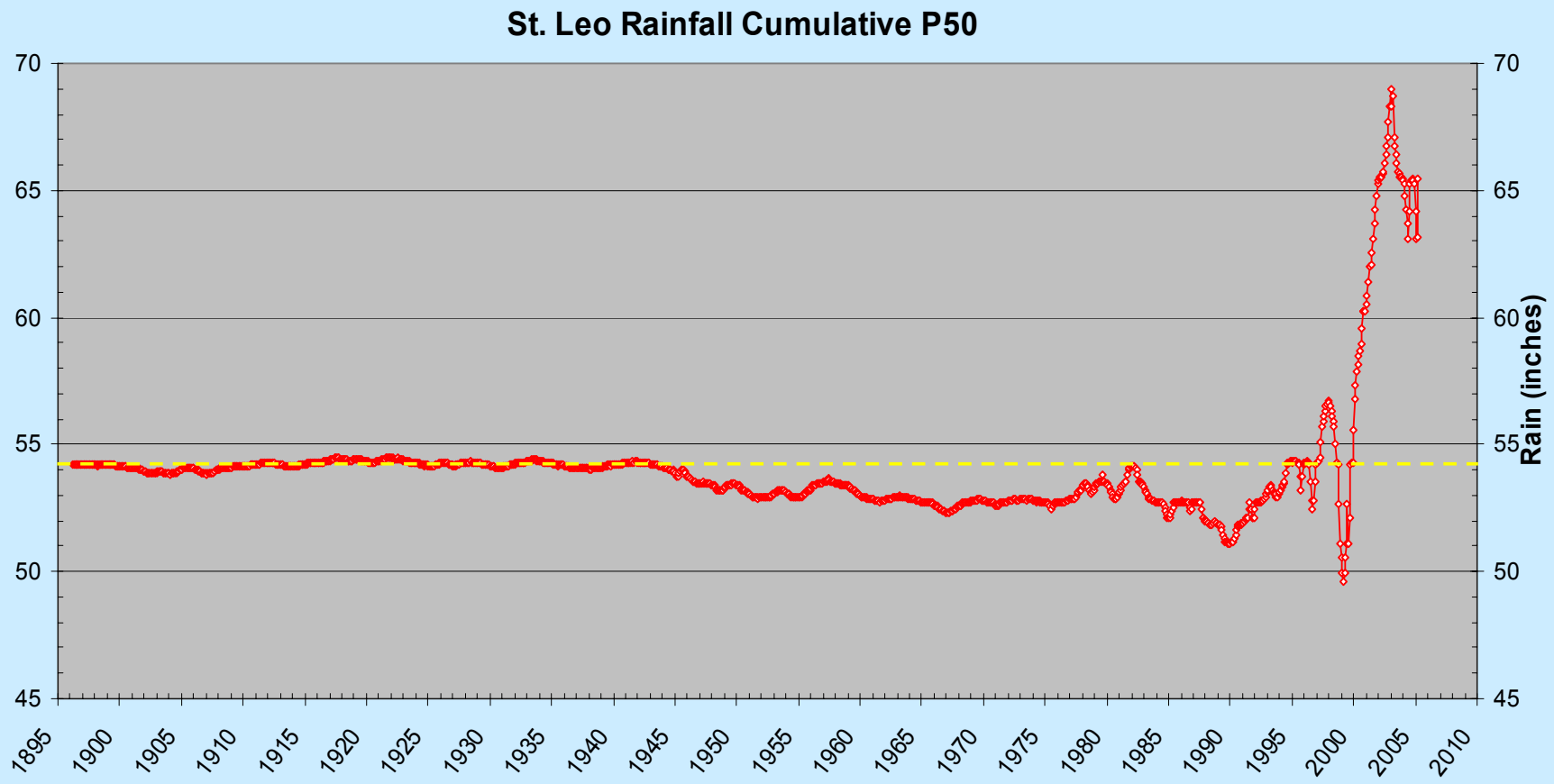
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Long Term 60 year P50


Cumulative Median Lake Deaton
Cuumulative Lake Median (NGVD)
66
65.5
65
64.5
64
63.5
63
62.5
62
61.5
61
60.5
1941
1946
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2006


Lake Deaton 60 Yr Median Minus Cumulative Median
Lake Median
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
0
60
120
180
240
300
360
420
480
540
600
660
720
780
Months from Start Date
Min
P50
Max


Brooksville Rain Gauge
Cumulative P50 Rain
64
62
60
58
56
54
52
50
48
1942
1947
1952
1957
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007


St. Leo Rainfall Cumulative P50
70
65
60
55
50
45
Rain (inches)
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
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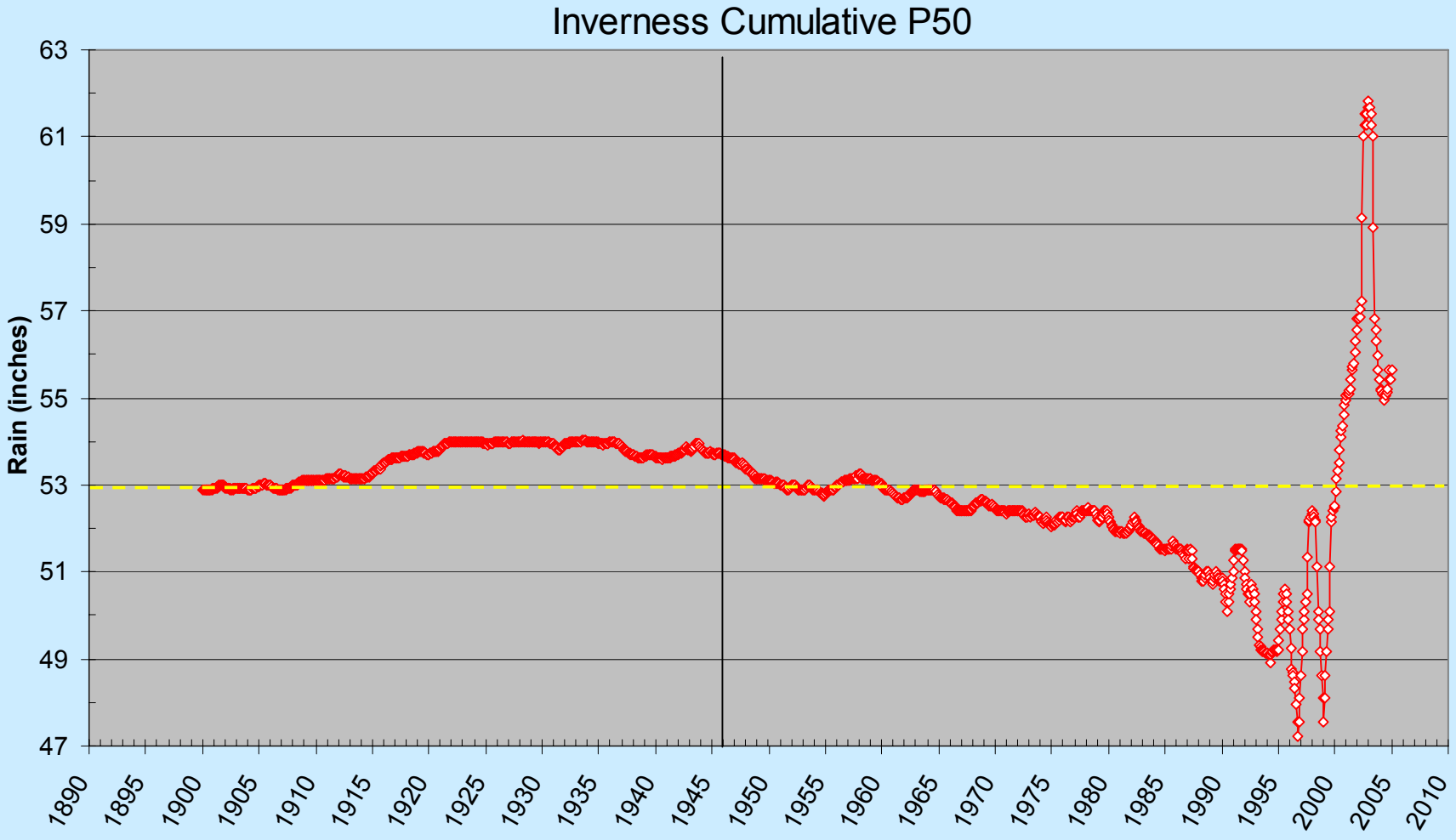
1970
1975
1980
1985
1990
1995
2000
2005
2010

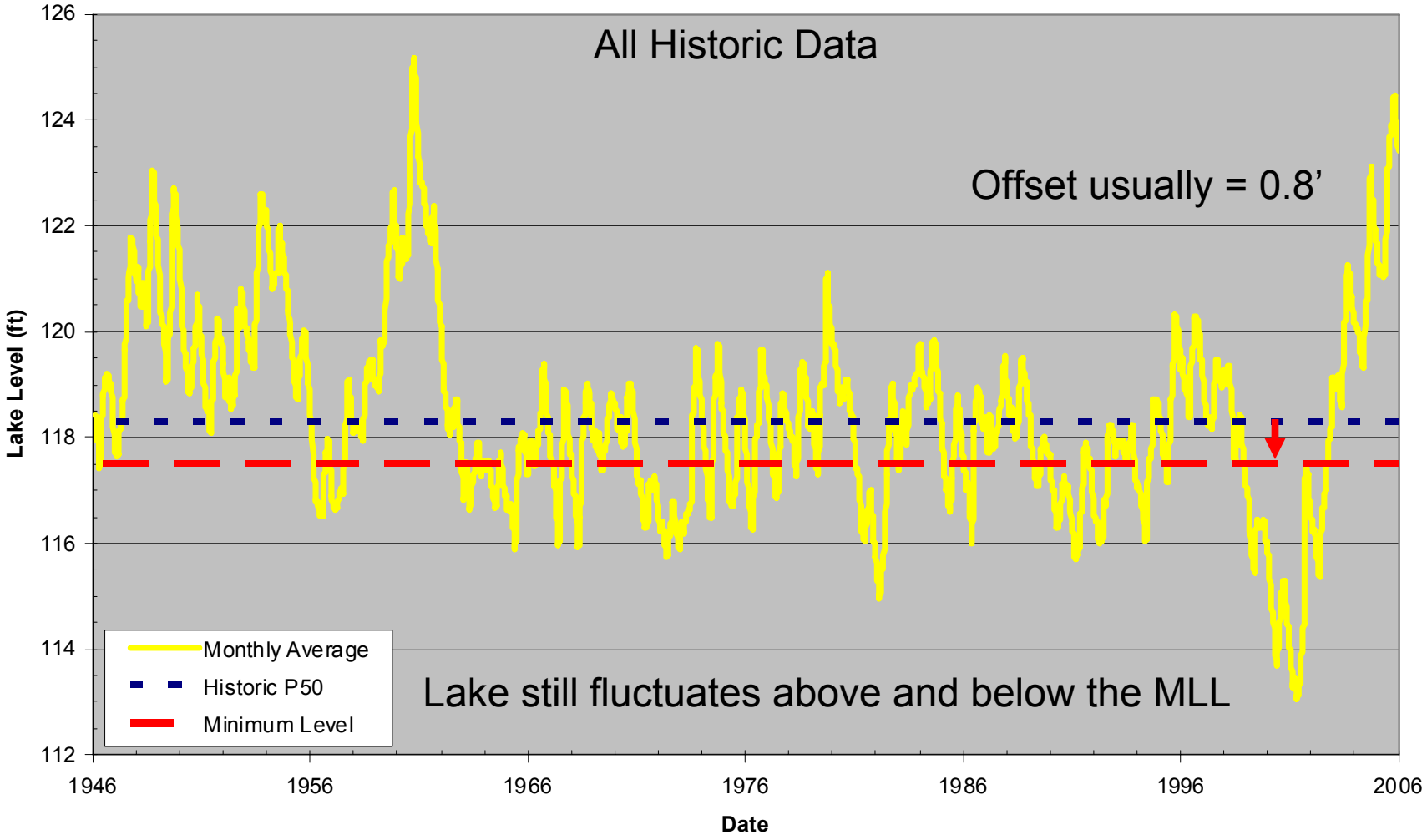

Inverness Cumulative P50
Rain (inches)
63
61
59
57
55
53
51
49
47
1890
1895
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

Calculating
Lake Stage Fluctuation Statistics Used to Set Lake Minimum Levels

In a perfect world you have long-term historic data and it's very easy!

Calculate the Historic P50 using the data and apply the appropriate offset.

Lake Example



We never have a perfect world situation.

- **Need method to calculate Long-Term Historic P50.**

- **Need a method to estimate what the natural stage of the lake should be at any moment based on preceding climatic conditions**

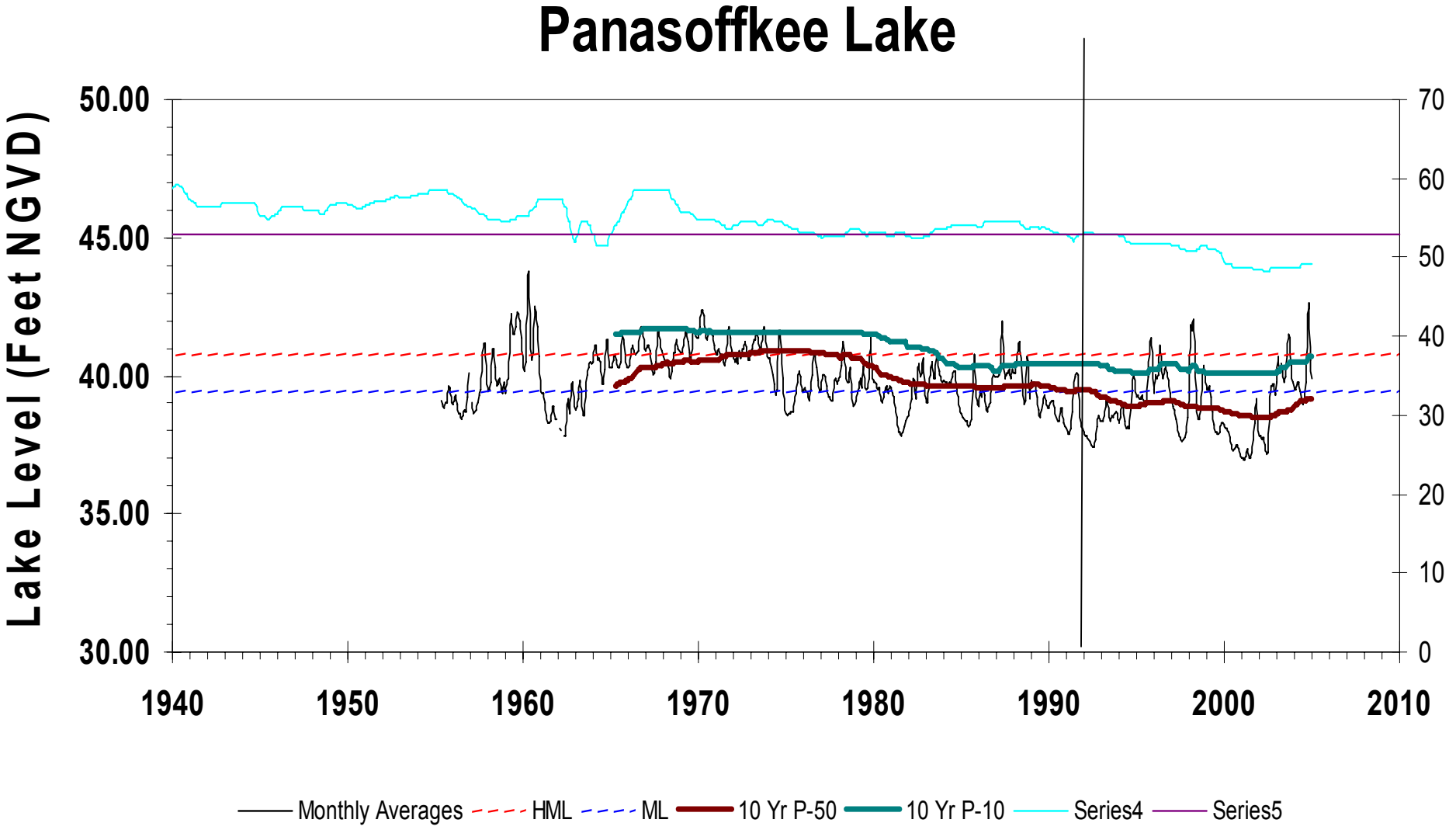
Typical lake has less than 20 years and very frequently has no historic data.

How are we handling this?

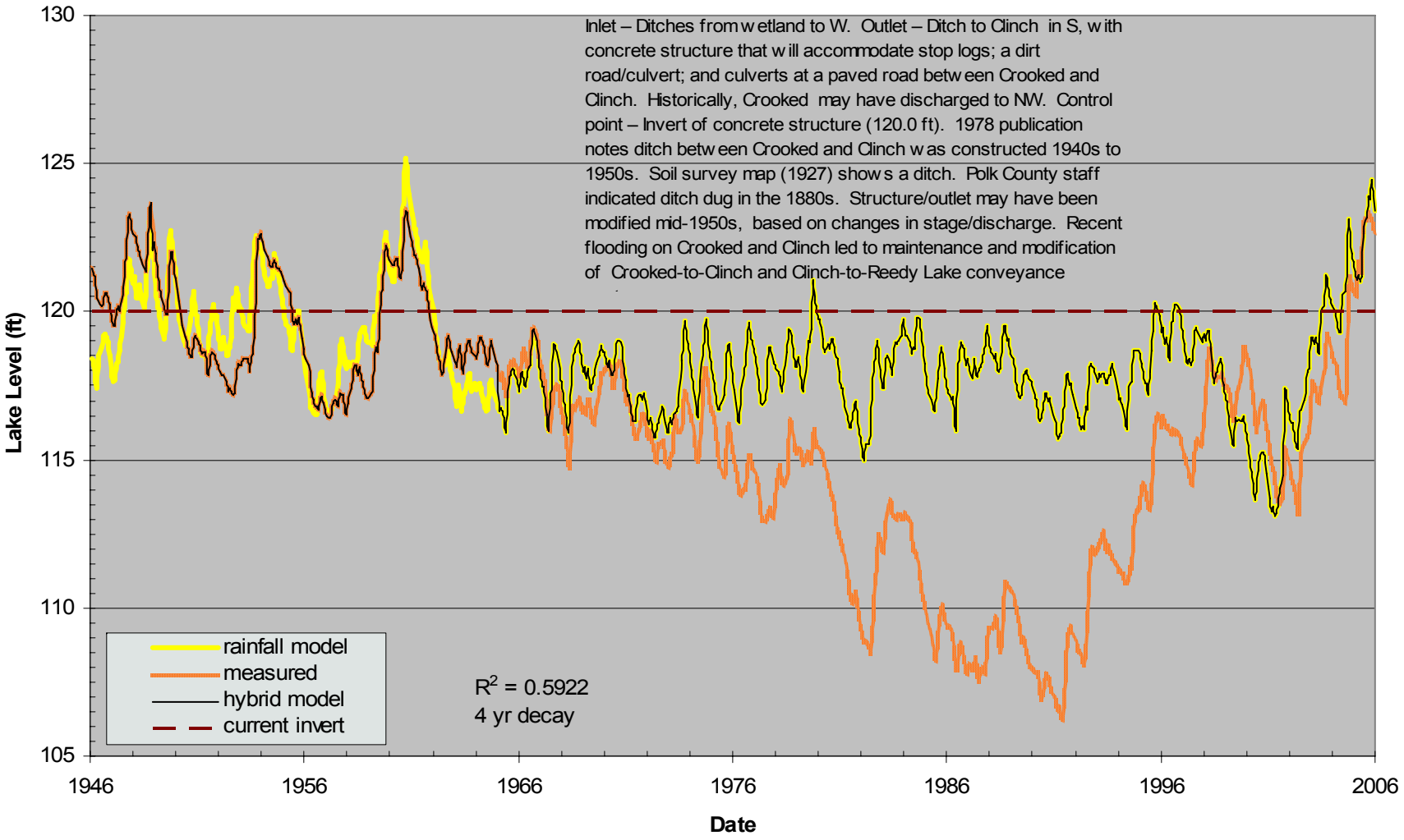
1. Old Way - Reference Lake Water Regime concept

2. New Way – Climate Based Models

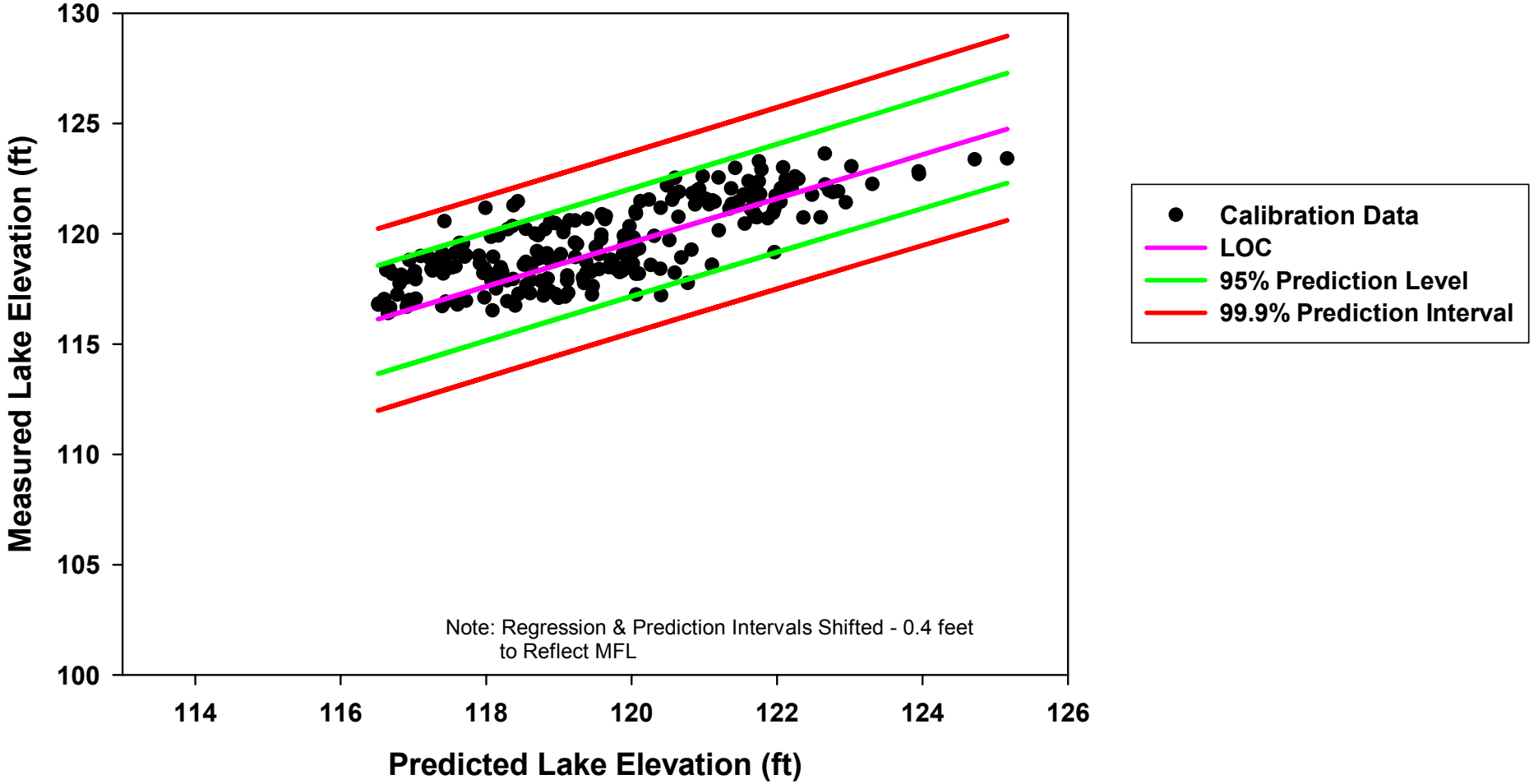
Goal: Estimate Lake Stage Given Climatic Conditions


Panasoffkee Lake
Lake Level (Feet NGVD)
50.00
45.00
40.00
35.00
30.00
70
60
50
40
30
20
10
0
1940
1950
1960
1970
1980
1990
2000
2010
Monthly Averages
HML
ML
10 Yr P-50
10 Yr P-10
Series4
Series5

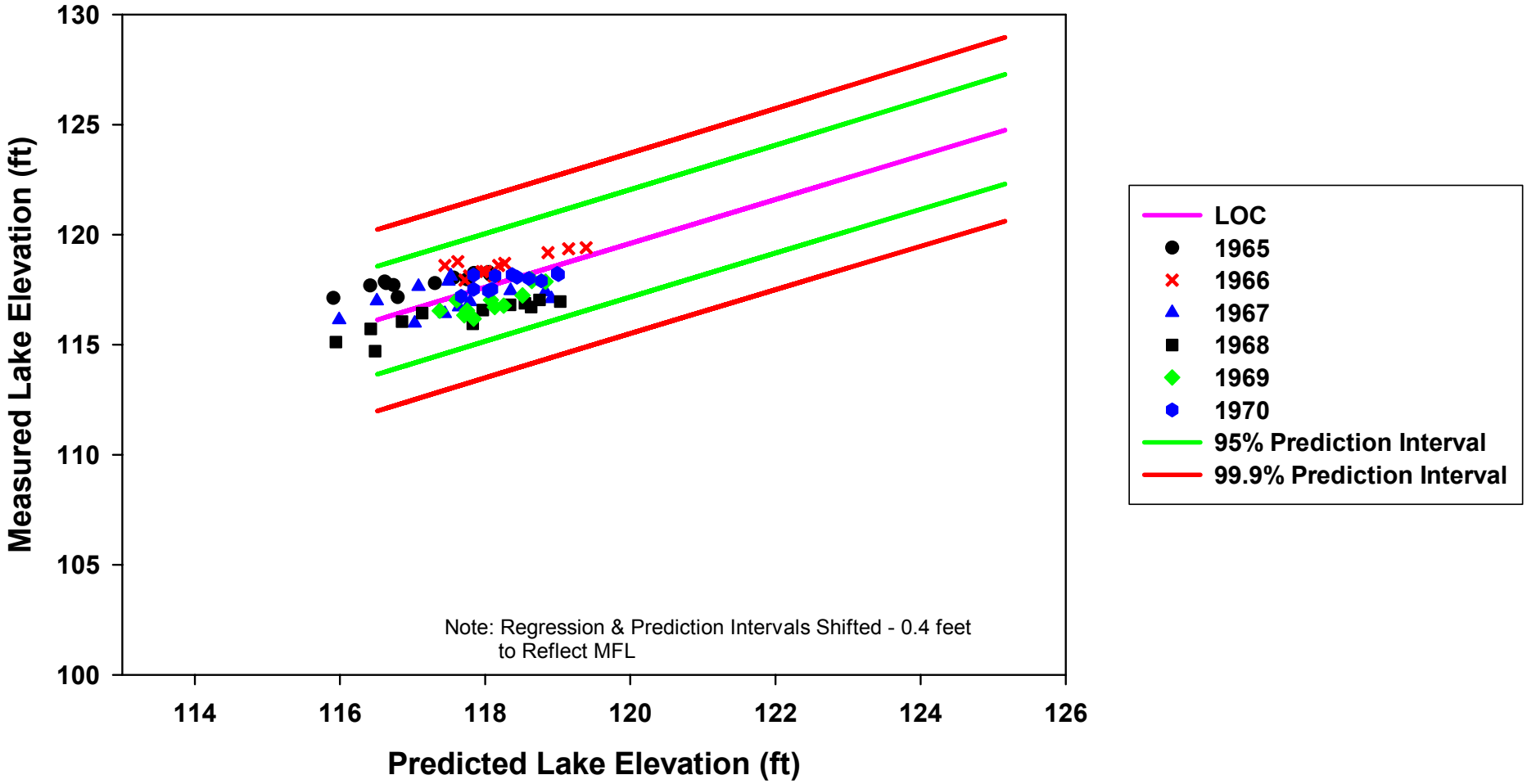
Crooked Water Level Models
Rainfall Model Based on Mountain Lake Rain Gage

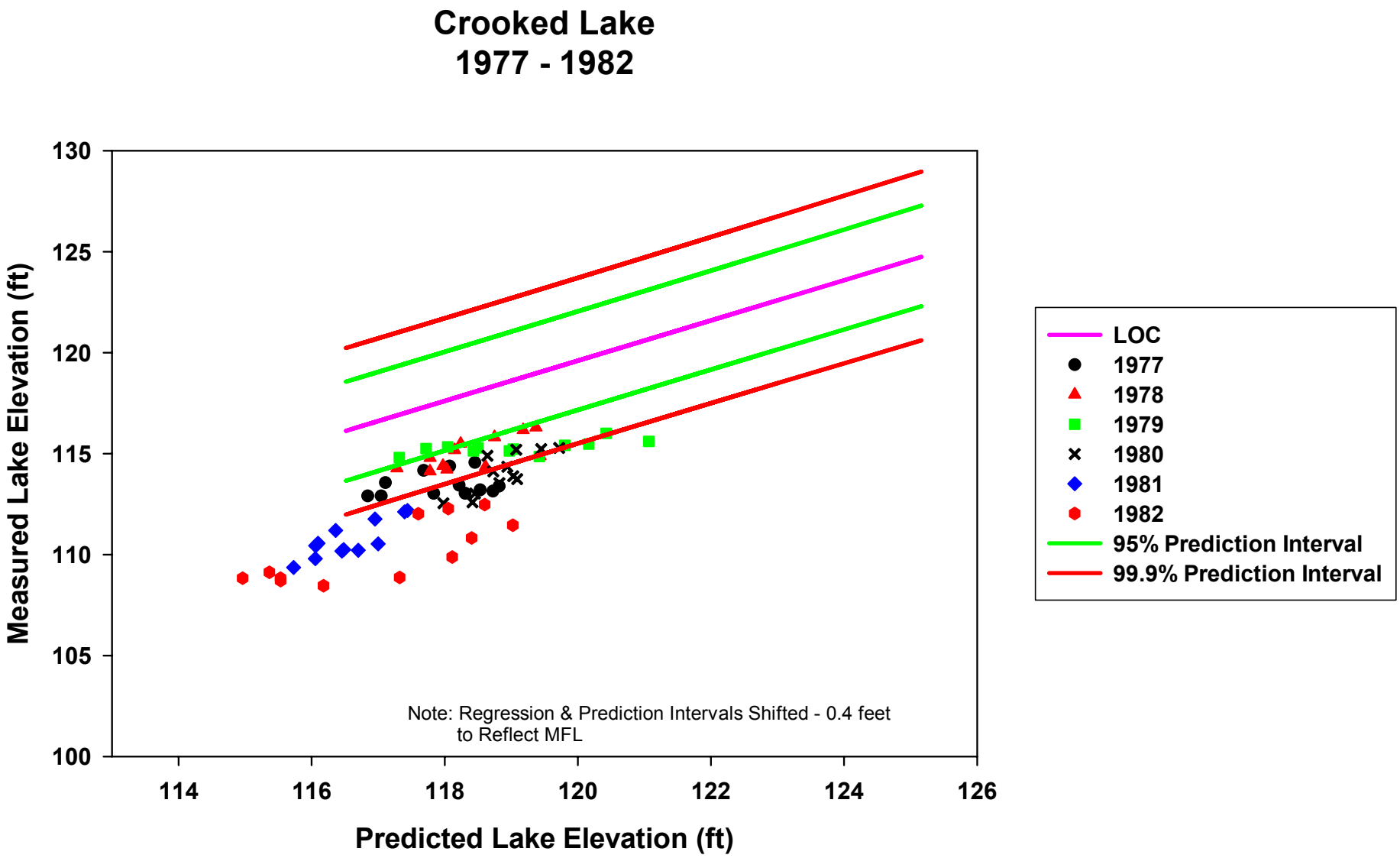


Crooked Lake
Calibration Period 1946 - 1964

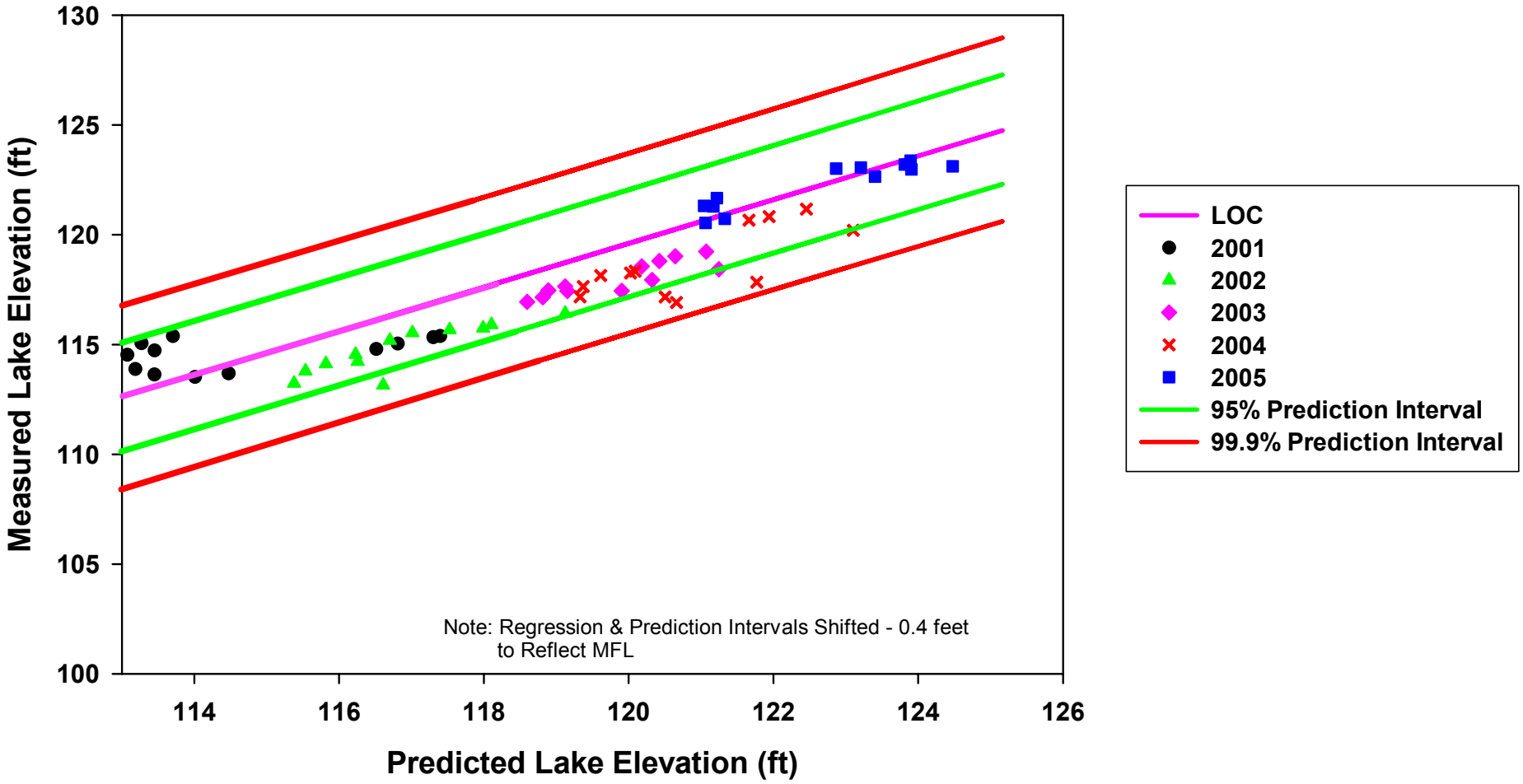


Crooked Lake
1965 - 1970




Crooked Lake
1977 - 1982
Measured Lake Elevation (ft)
130
125
120
115
110
105
100
114
116
118
120
122
124
126
Predicted Lake Elevation (ft)
Note: Regression & Prediction Intervals Shifted - 0.4 feet
to Reflect MFL
LOC
1977
1978
1979
1980
1981
1982
95% Prediction Interval
99.9% Prediction Interval

Crooked Lake
2001 - 2005



Future Discussions

Creating Long-term Models Based on Climate

Evaluation of Compliance Based on Climatic Conditions