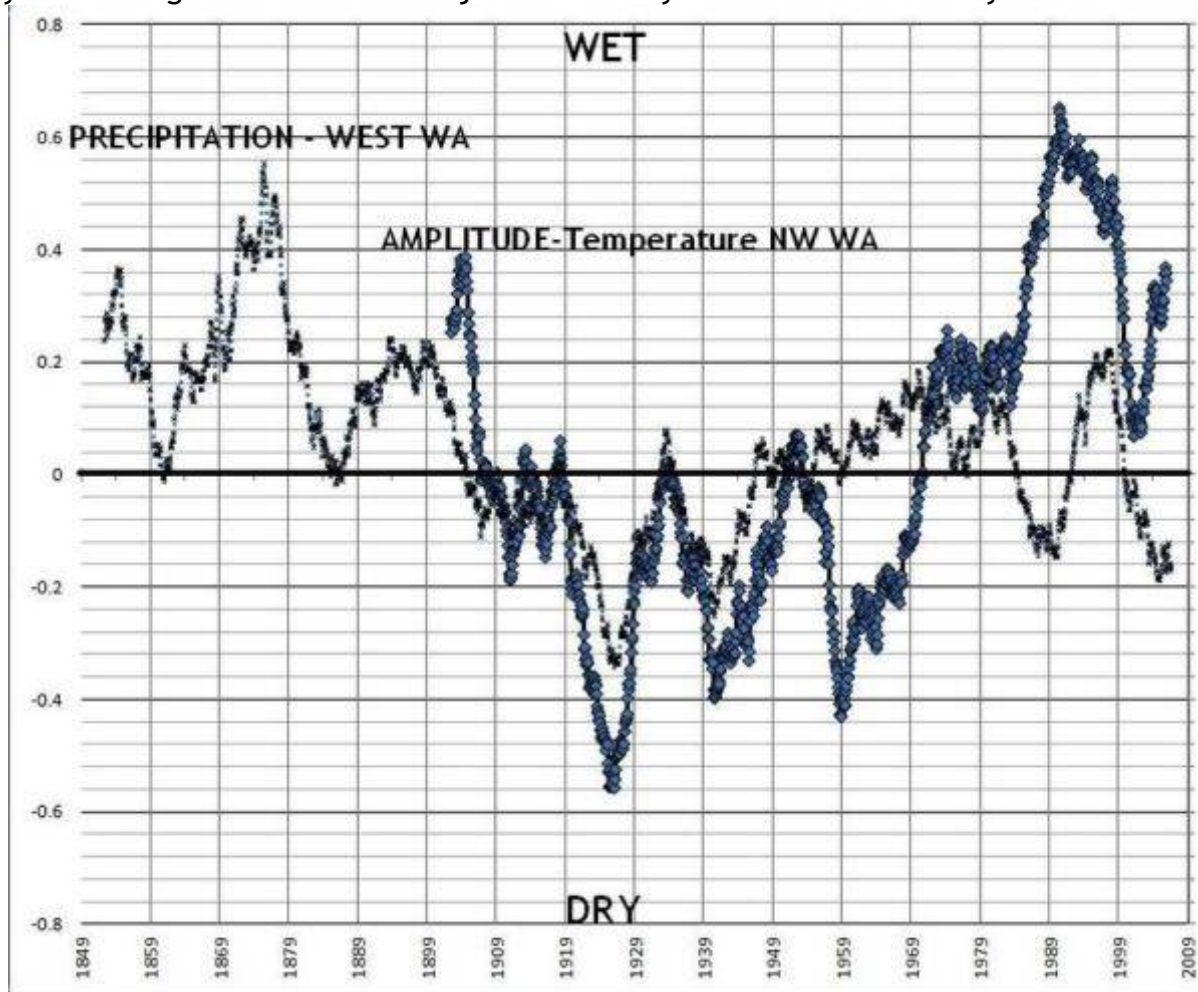


CLIMATE RECORD OF WESTERN WASHINGTON

By Gary Morris
REVISIONS AS OF JUNE 2010

PRECIPITATION OF WESTERN WASHINGTON AND SKY COVER (TEMPERATURE AMPLITUDE) OF NORTHWEST WASHINGTON

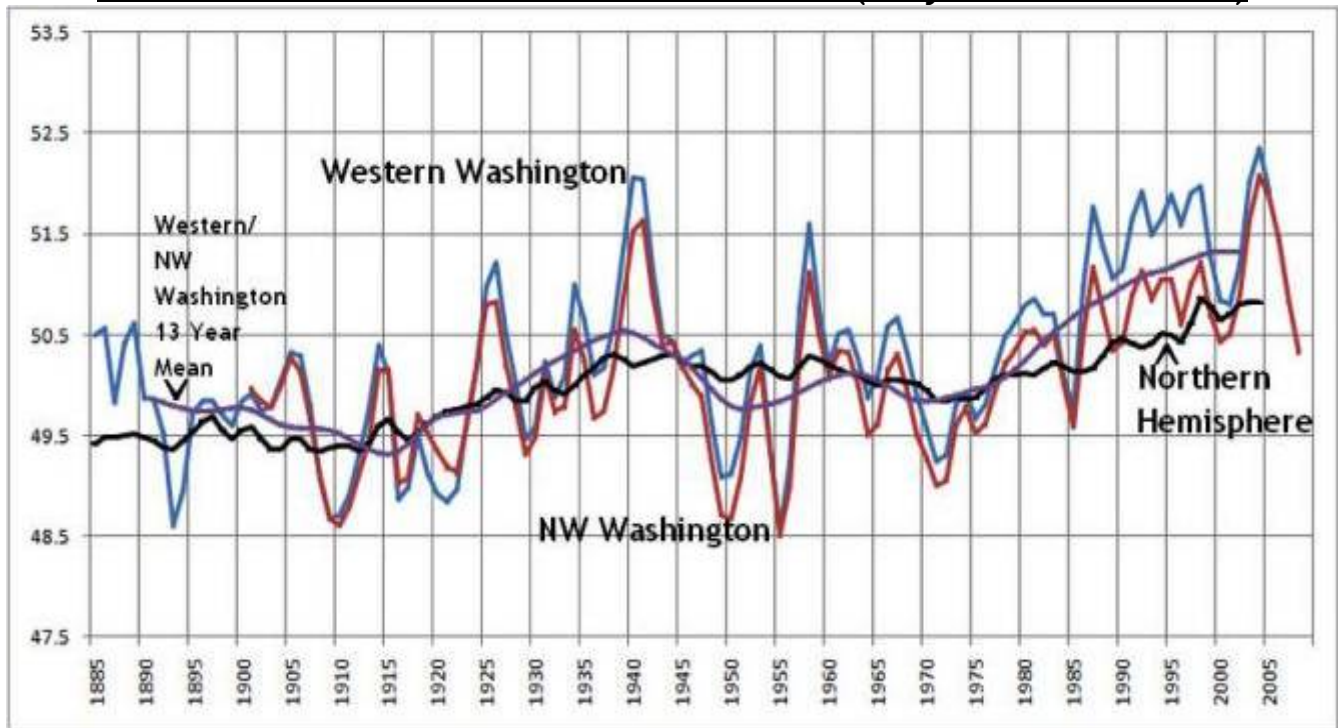
(seven year running mean of annual-adjusted monthly means - Note the 18 year lunar nodal cycle)



TEMPERATURE

WESTERN / NORTHWESTERN WASHINGTON 1885-2010

NORTHERN HEMISPHERE ANNUAL AVERAGE (very similar to World)



(Two year average of annual means)

Note the rise in Average temperature since about 1985 (or earlier)

Northern Hemisphere standardized departure in Celcius, adjusted to Fahrenheit, with an adjusted mean for comparison of 50 degrees.

The Northern Hemisphere (and world) may not respond to short term variations, but to variations 10-20 years and longer

Western/NW Washington is responding similar to in the long term to Northern Hemisphere (World) average temperature changes.

CLIMATE RECORD OF WESTERN WASHINGTON

WESTERN WASHINGTON AVERAGE

TEMPERATURE AND PRECIPITATION 1890-1994 adjusted equivalent

Using 10 evenly distributed station records (1891-1994)

Average temperature: 50.35°F ± 0.93°F

	0	1	2	3	4	5	6	7	8	9
1990	50.88	51.11	52.38	50.46	51.43					
1980	50.74	51.54	50.20	50.92	50.44	48.81	51.50	51.77	50.92	50.68
1970	49.83	49.21	49.39	50.10	50.46	49.43	50.64	50.46	51.41	51.01
1960	50.23	51.31	50.60	51.24	49.40	50.71	50.79	51.36	50.51	50.00
1950	49.28	50.18	50.38	51.59	49.72	48.21	49.84	50.73	53.43	50.53
1940	52.73	52.83	51.32	50.56	51.06	50.38	50.33	51.33	49.88	49.79
1930	49.74	51.26	50.09	49.37	52.86	50.12	50.63	50.37	51.01	51.40
1920	49.32	49.62	48.66	50.47	49.93	51.57	52.44	50.20	51.13	49.50
1910	49.38	48.47	50.11	49.43	50.80	51.11	47.89	49.36	50.33	49.01
1900	50.70	49.22	49.53	49.67	50.30	50.37	51.15	50.05	49.46	48.26
1890	49.28	50.39	49.95	48.04	48.87	49.53	49.25	49.67	49.86	49.49
1880	47.77	49.62	48.87	48.89	49.18	51.70	50.32	48.98	50.77	51.50
	(2)	(2)	(2)	(3)	(5)	(5)	(5)	(5)	(5)	(5)
1870	51.72	50.42	50.72	49.72	50.82	50.52	50.42	51.12	50.87	49.32
# Stations	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(2)	(2)

AVERAGES USED:

Tatoosh	49.1	Everett	50.6	Quillayutte	48.4	Vancouver (WA)	52.4
Olga	49.5	Aberdeen	50.0	Victoria (BC)	49.6	North Head	50.4
Elaine	49.0	Puyallup	51.1	Centralia	51.5		

WESTERN WASHINGTON

AVERAGE ANNUAL PRECIPITATION

% Departure from 1890-1980 Average at each site, proportionately weighted

Using 15 stations+, from the Olympic Coast and greater San Juan Islands

	0	1	2	3	4	5	6	7	8	9
1990	128	097	092	079	099					
1980	098	108	112	116	116	074	098	079	097	093
1970	091	121	110	090	106	118	086	094	079	090
1960	092	110	092	098	103	100	102	115	118	084
1950	116	097	069	118	105	112	109	084	098	109
1940	094	087	084	074	071	103	096	099	116	094
1930	075	108	127	129	102	092	095	110	082	093
1920	112	122	079	087	087	085	088	103	081	061
1910	111	087	104	093	099	095	102	111	103	098
1900	108	102	113	104	102	091	106	092	096	106
1890	093	121	104	129	127	096	121	118	093	126
	(8)	(114)	(11)	(12)	(15)					
1880	114	126	111	095	086	099	106	124	103	078
	(7)	(6)	(7)	(7)	(9)	(9)	(9)	(8)	(8)	(8)
1870	136	098	107	111	110	148	112	112	111	140
	(2)	(1)	(2)	(2)	(5)	(2)	(2)	(2)	(6)	(7)
1860	076	084	069	093	085	116	---	135	069	071
	(2)	(2)	(2)	(2)	(2)	(3)		(3)	(2)	(1)

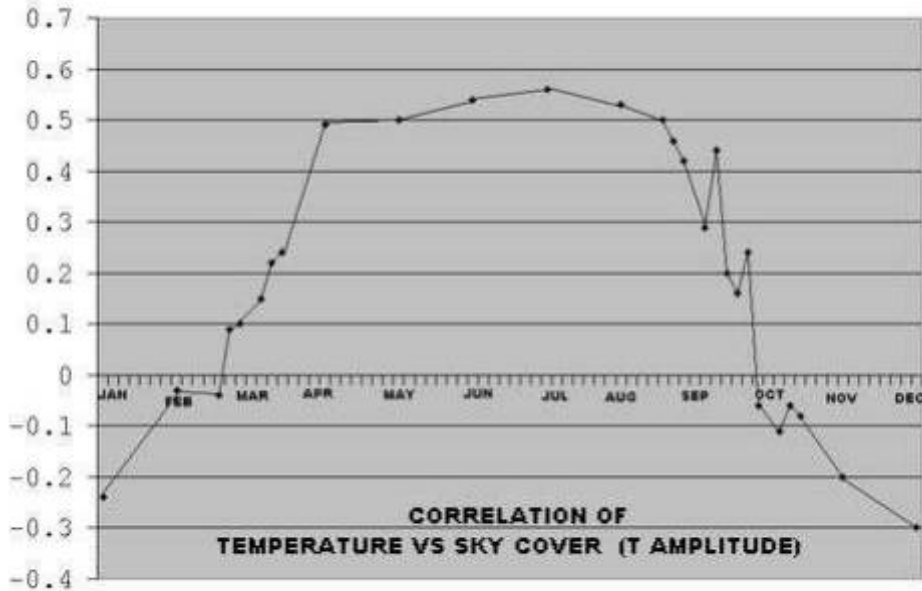
CLIMATE RECORD OF WESTERN WASHINGTON

CORRELATION OF TEMPERATURE TO CLOUDINESS

Using the temperature Hi minus low (TEMPERATURE AMPLITUDE) as an index of cloudiness, this index is correlated to temperature, and shows that summer cycles are warm/clear vs cool/cloudy and winters are warm and cloudy vs cold and clear. The temperature amplitude is a more accurate record of cloud cover than precipitation (over half the annual precipitation falls in the four winter months, vs 10 percent in the three summer months -- thus temperature amplitude covers percent sky cover throughout the whole year equally).

(WESTERN WASHINGTON 10 AVG STATIONS 1931-2001)

MONTH OF YEAR	1	2	3	4	5	6	7	8	9	10	11	12
CORRELATION	-.24	-.03	.15	.49	.50	.54	.56	.53	.38	.01	-.20	-.30



COMPARISON OF BAROMETRIC PRESSURE AND CLOUDINESS (USING AMPLITUDE INDEX)

Barometric Pressure consistently preceeds sky cover by an average of 1.2 days, and the correlation of cloudiness (any lag) compared to pressure is strongest in summer and weakest in winter. (Highest pressure 1.2 days before clearest skies, and lowest pressure 1.2 days before cloudiest skies).

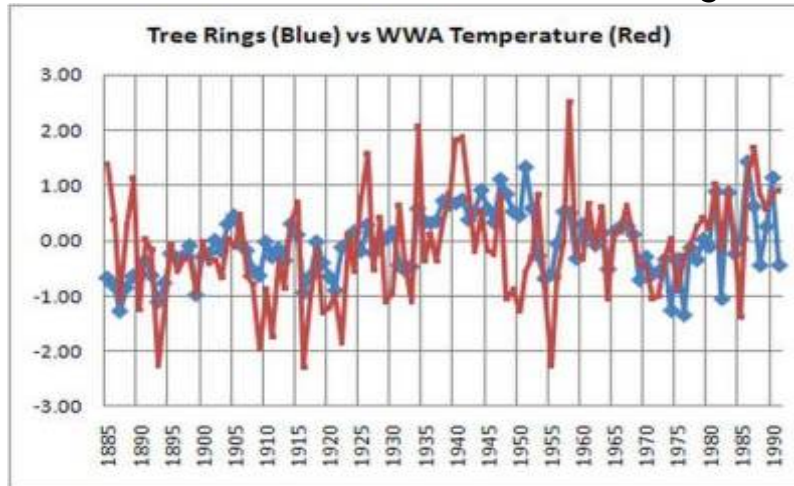
(LYNDEN, WASHINGTON 6 YEARS 2002-2007)

MONTH OF YEAR	1	2	3	4	5	6	7	8	9	10	11	12	
CORRELATION	0.29	0.35	0.32	0.35	0.45	0.59	0.42	0.44	0.38	0.33	0.21	0.10	avg .375 correlation
LAG Amp from PR	1.4	1.8	0.5	1.0	1.1	1.3	1.2	1.2	1.4	1.4	0.6	0.8	avg 1.17 days

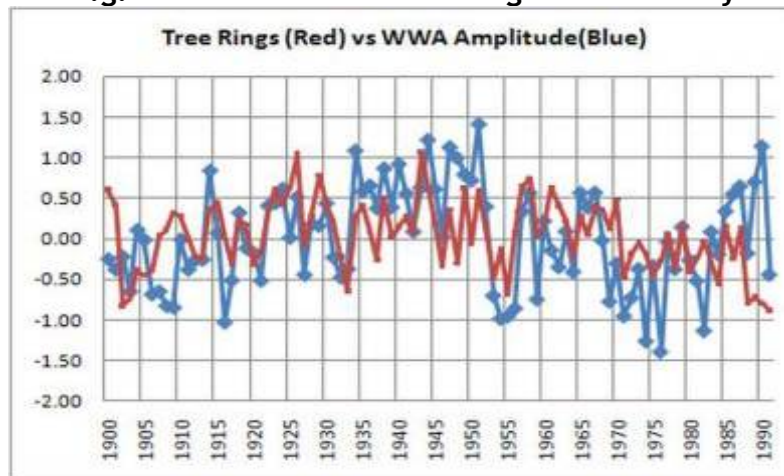
WESTERN WASHINGTON CLIMATE RECONSTRUCTED FROM TREE RINGS (1520 to 1990 AD)

Using published data on tree rings from the Pacific Northwest, correlation coefficients were constructed examining response to monthly temperature and amplitude (% sky cover), as well as summer (April, May, June, July, August, September) and annual correlations. Using sites with the highest correlation to Washington annual temperature and amplitude, it is possible to reconstruct past climate: reconstructed temperature has a correlation of $r=0.48$, and summer half $r=0.56$; reconstructed amplitude (sky cover) did not fair as well, annual $r=-0.40$ and summer half $r=-0.36$. However, the reconstruction was a very simple multisite average, and future reconstruction, using site % correlation should boost the overall correlation by perhaps 0.10 points.

**Western Washington Annual Temperature
Reconstruction 1885-1990 from Tree Rings**

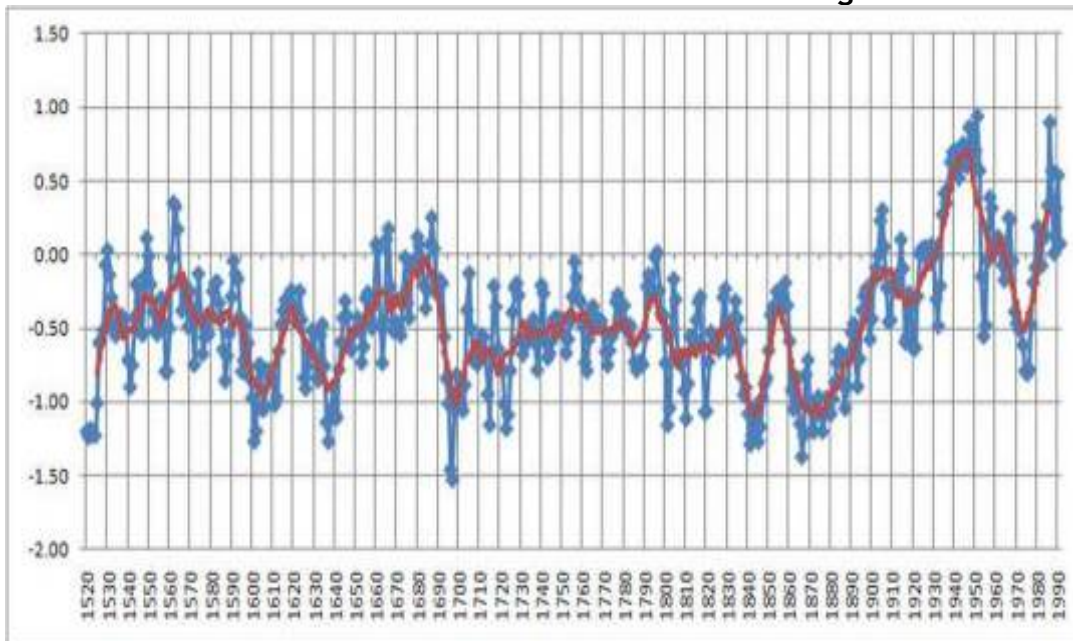


**Western Washington Annual Sky cover (Temperature Amplitude)
Reconstruction 1900-1990 from Tree Rings
e.g. - Positive is clear and negative is cloudy**

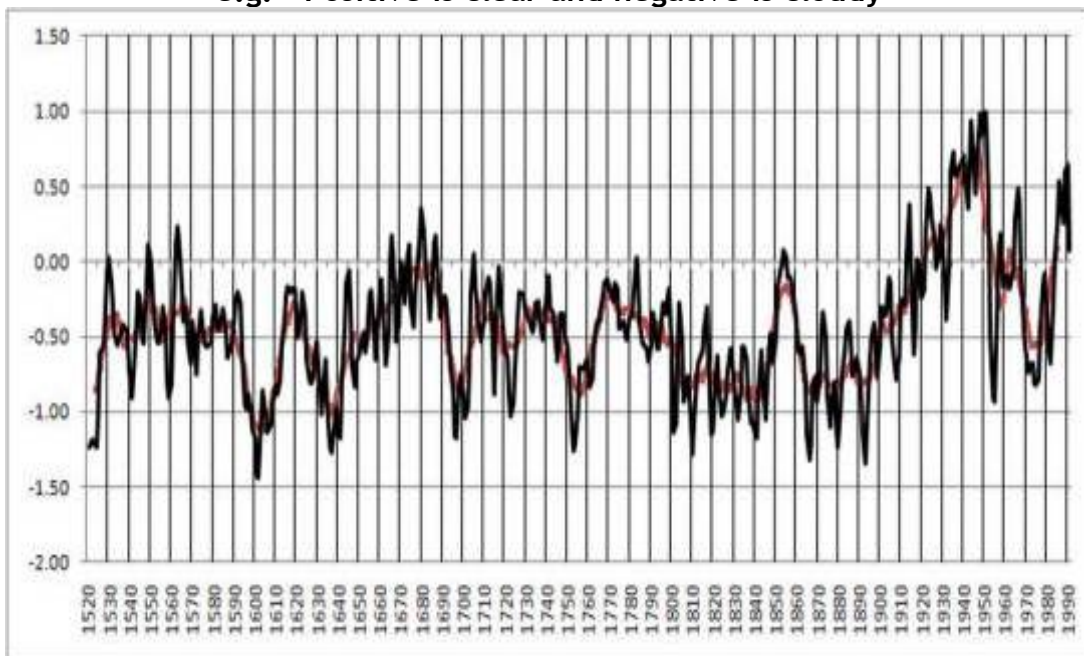


CLIMATE RECORD OF WESTERN WASHINGTON

**Western Washington Annual Temperature
Reconstruction 1520-1990 from Tree Rings**



**Western Washington Annual Sky cover (Temperature Amplitude)
Reconstruction 1520-1990 from Tree Rings**
e.g. - Positive is clear and negative is cloudy



[Tree Ring Response to Climate in the San Juan Islands.doc](#)

PREHISTORIC CLIMATE RECORD OF THE PACIFIC NORTHWEST

Prehistoric Record of Climate in the Pacific Northwest, the past 6,000 years, derived from pollen records of a dozen lake records in the Pacific Northwest, including lake sedimentation rates per century.

The prehistoric climate record is preserved in lake and bog sediments where the ratios of microscopic pollen from climate sensitive trees can give an estimate of annual precipitation and average summer temperature.

Using 45 sediment core and pollen records, it was possible to derive over 30 time adjusted series of climate records (annual precipitation, temperature, or lake sedimentation rates). Severe cool and wet (and stormy) intervals are highly correlated with dozens of dated sites (e.g. - river flooding, shoreline erosion events) of western Washington and southwest British Columbia.

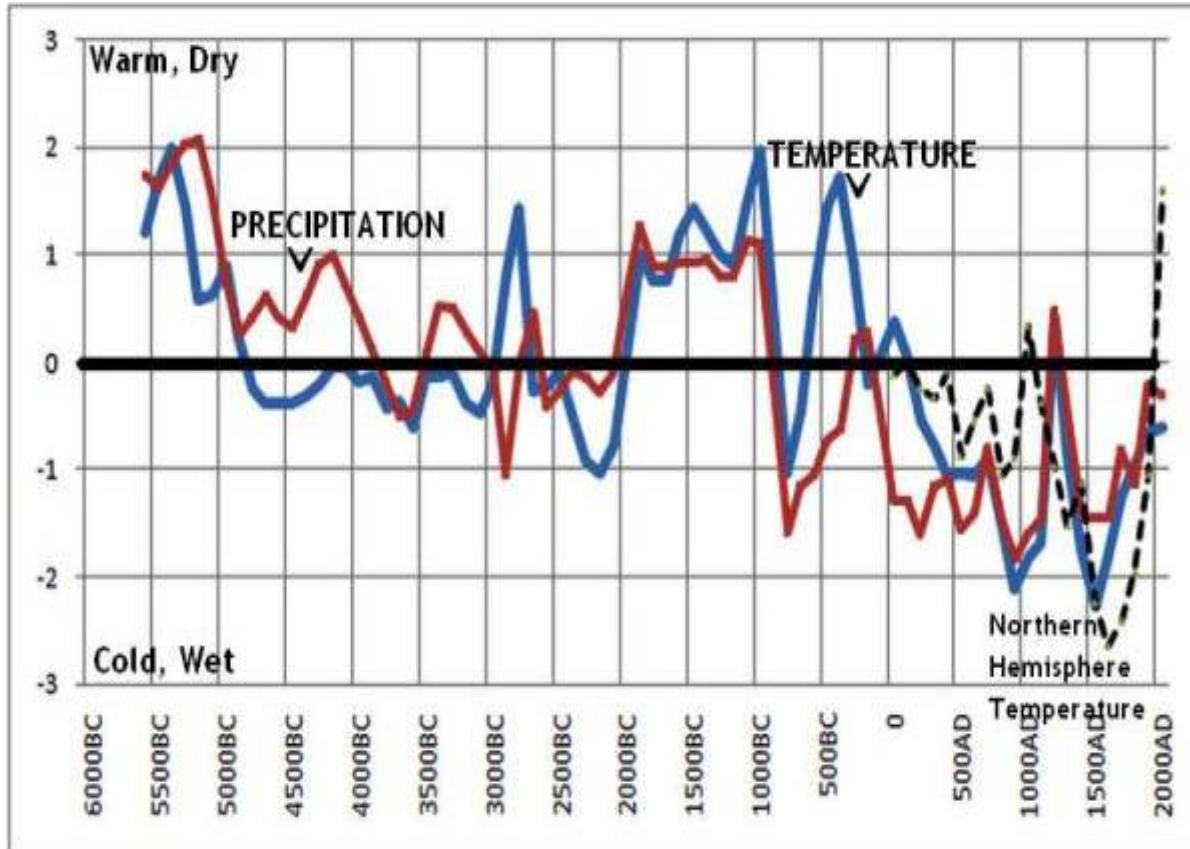
The dominant character of climate oscillations reveals an extremely high correlation between warm, dry climate and mild erosion (sedimentation) rates vs. a cool, wet climate and extreme erosion (sedimentation) rates.

Climate oscillations, of a few hundred years to several millennia in length, are caused by solar variations, or variations in the geomagnetic field of the earth (which may also be affected by the Sun). The prehistoric record of geomagnetic intensity and the variation of the geomagnetic North Pole both reveal a high correlation with Pacific Northwest Climate Cycles.

Climate cycles exist mainly as half cycles and half cycles of half cycles, etc. Climate cycles are found at about 5600, 2700, 1400, 700, and 350 years (etc). Most all cycles vary in period length and amplitude according to the phase of longer term cycles. This is noticeably true with these long term cycles (350 to 2700 years). For example, the period length of the 700 year cycle is dominantly controlled by the 1400 year, 2700, (5600), and long term cycles. The variation is mainly towards larger and longer amplitudes during the warm period of the longer term cycles and smaller and shorter amplitudes during the cool period of the longer term cycles.

CLIMATE RECORD OF WESTERN WASHINGTON

CLIMATE RECORD OF THE PACIFIC NORTHWEST (to 8,000 years ago) SOLAR (Calendar) Years Standardized Temperature and Precipitation



Derived from Palynology of dozens of Lakes and Bogs in the Pacific Northwest

Temperature from percent Garry Oak (to all trees) and precipitation is the ratio of Lodgepole Pine to Hemlock

Average July Temperature: 62.12 Degrees ± 0.72

Average Annual Precipitation: Departure from Normal - 0.00% ± 6.385

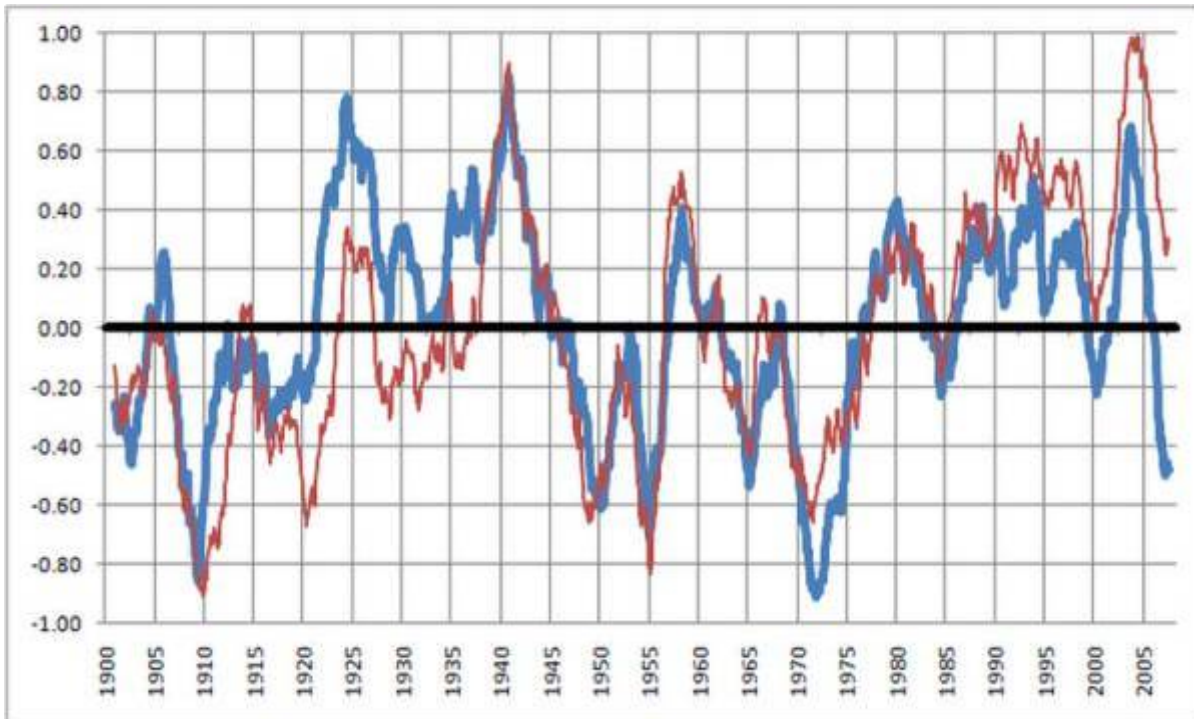
Dashed Line is 100 year averages of Northern Hemisphere Temperature adjusted to the past 2,000 year departure

Note that Temperature and Precipitation reconstruction is highly correlated ($R=.70$), but the timing at times may be off by more than 50 years

*Based on original manuscript 1987 "Forecasting Pacific Northwest Climate: The Theory Behind How Climate Cycles Work" by Gary J. Morris

CLIMATE RECORD OF WESTERN WASHINGTON

**SE Alaska Average Monthly Temperature 1900-2010 (Solid Blue line), 2 year running mean
Average of 16 sites in 6 equidistant areas in SE Alaska, standardized data
Compared with NW Washington (thin red line), same time period**



**Note that the 1910s and 1920s were warmer in Alaska than NW Washington
and 1990 to recent are cooler than NW Washington**