

# **Climate Structure, Variability, and Suitability for Viticulture and Wine Production in the Puget Sound of Washington**

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At the regional scale the weather and climate of the Puget Sound is driven by latitude, proximity to the ocean, and its location to the westerly winds and the associated seasonality of storms coming off the Pacific. At the more local scale the weather and climate are strongly influenced by the Olympic Mountains and the lay of the landscape. Precipitation on the west side of the Olympic Peninsula ranges from an average of 90 inches or more a year near the coast to over 200 inches or more for Mount Olympus (7,965 feet above sea level). The inner region of the Puget Sound is largely in the rain shadow of the Olympic Mountains, but varies tremendously from place to place. Some of the lower rainfall amounts are found in the region around Sequim, where only 16-18 inches of annual rainfall occurs. The proximity to the ocean and the westerly wind systems produces a ratio of overcast days to clear days of about two to one, but also moderates the temperatures in both the winter and summer.

Regional climate variability is largely controlled by two dominant features of the Pacific Ocean sea surface temperatures and atmospheric circulation: the El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). ENSO is centered in the equatorial Pacific and represents a see-saw in both ocean temperatures and atmospheric pressure east to west across the tropical region with a periodicity of 3-7 years. ENSO has three main phases; El Niño, La Niña, and neutral. During periods of El Niño conditions in the tropical Pacific (warmer surface waters off the South American coast), the Pacific Northwest (PNW) is generally drier. During La Niña conditions in the tropical Pacific (colder surface waters off the South American coast), the Pacific Northwest (PNW) is generally wetter. The PDO represents variability in SSTs in the extratropical Pacific Ocean with a period of around 50 years with the cold phase typically bringing colder and wetter conditions to the PNW and the warm phase bringing warmer and drier conditions (Jones and Goodrich, 2007).

A study of long-term stations in the western United States (Jones, 2005; Jones and Goodrich, 2007) including the stations of Centralia, Grapeview, Port Townsend, the Puyallup Experiment Station, and Sedro Woolley in the Puget Sound AVA reveals a regional cool climate structure with an average of 1770 growing degree-days, and a growing season and ripening period of 57.8°F and 59.2°F, respectively (Table 1). The region is largely free of heat extremes and has low frost frequency. The median last spring frost is April 7<sup>th</sup>, but varies over 71 days from the coolest to warmest stations. The median first fall frost is November 1<sup>st</sup>, but can occur as early as October 1<sup>st</sup> and as late as December 8<sup>th</sup> (Table 1). The resulting frost-free period averages 207 days over the region, ranging from 154 to 269 days. Growing season precipitation (Apr-Oct) averages near 15 inches for the five locations with 2 to 4 inches of rainfall expected during either the bloom (May 15 – June 15) or ripening periods (August 15 – October 15). Regional climate variability mechanisms (ENSO and PDO) appear to play a moderate role in climate variability in the region with the cold phase of the PDO having some of the coolest growing seasons while La Niña conditions typically bring wetter periods. Trends over the 1948-2004 time period in the Puget Sound AVA exhibit growing seasons that are 56 days longer (Figure 1) due to earlier last spring frosts and later first fall frosts (Jones, 2005). These longer growing seasons are on average 1.8°F warmer than in the middle of the last century with more warming coming at night than during the daytime (Figure 2). Growing degree-days have increased 320 units over the 58 years (Figure 3) while the frequency of days below freezing has declined in all seasons and annually.

The climate structure of the Puget Sound region is one of moderate temperatures due to its location relative to the ocean. Precipitation varies markedly across the region, but benefits tremendously from the rain shadow of the Olympic Mountains with many areas experiencing from 15 to 30 inches of rainfall per year. Growing seasons across the region are typically longer than 180 days with little frost pressure. Growing degree-days for the best landscapes vary from 1400 to 2300 units, providing a range of cool, early ripening variety climate types. This talk will detail the temporal and spatial variation of climate in the region and discuss its broad suitability to viticulture and wine production.

**References:**

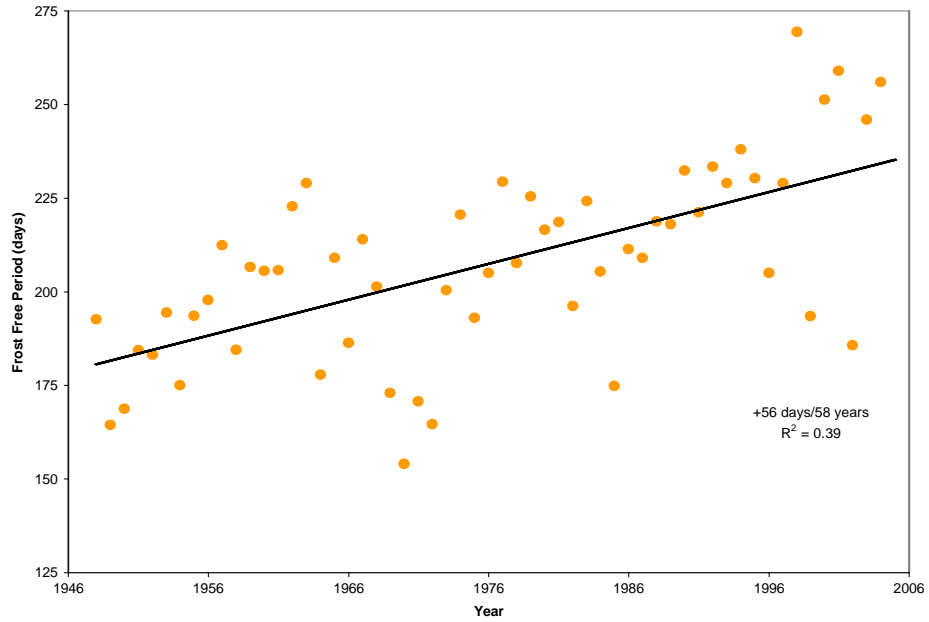
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Jones, G.V. and Goodrich, G.B. (2007). Influence of Climate Variability on the U.S. West Coast Wine Regions and Wine Quality in the Napa Valley. *Climate Research* (in press).

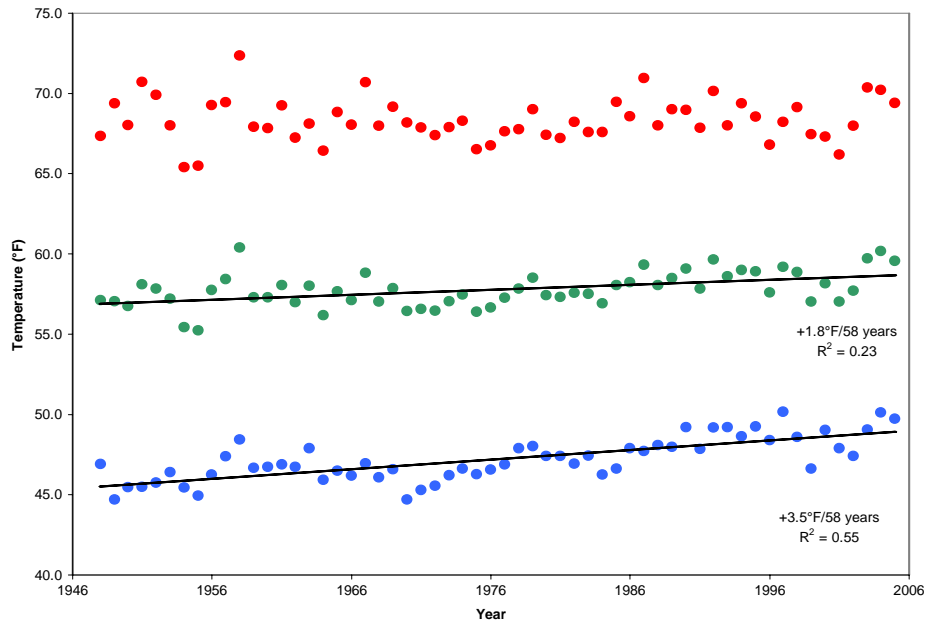
**Tables and Figures:**

**Table 1** – Climate characteristics average over five stations over 1948-2004 for the Puget Sound AVA (Jones, 2005).

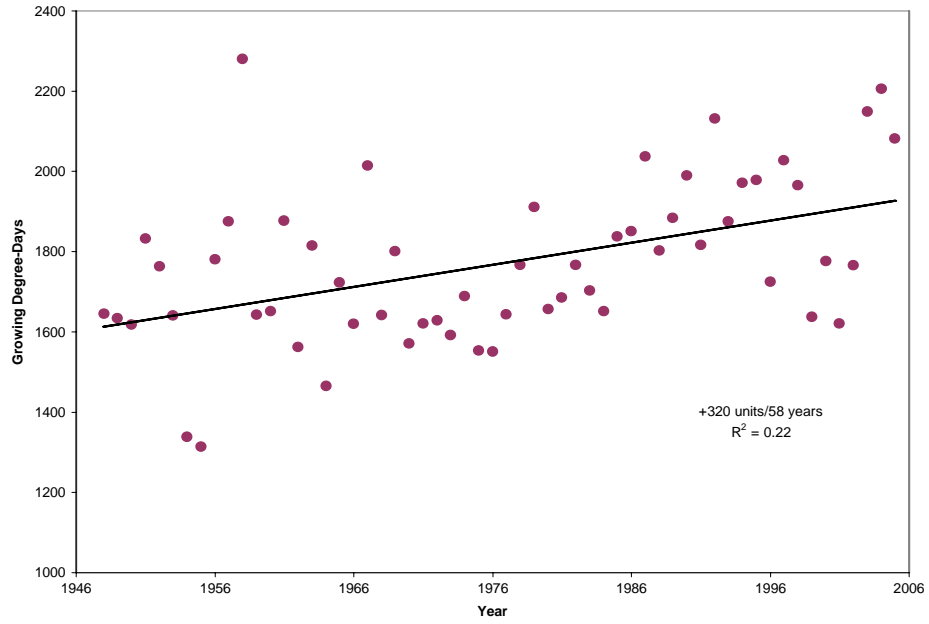
Variable	Mean	Median	Stdev.	Max.	Min.	Range
Growing Degree-Days (base 50°F, Apr-Oct)	1770	1765	199	2280	1314	966
Growing Season Average Temperature (Apr-Oct)	57.8	57.7	1.1	60.4	55.2	5.2
Growing Season Average Maximum Temperature	68.3	68.0	1.3	72.4	65.4	7.0
Growing Season Average Minimum Temperature	47.2	46.9	1.4	50.2	44.7	5.5
Ripening Average Temperature (Aug15-Oct15)	59.2	59.2	1.4	62.4	56.7	5.7
Growing Season # of Days > 95°F (Apr-Oct)	2	2	2	6	0	6
Ripening # of Days > 95°F (Aug15-Oct15)	1	0	1	4	0	4
Annual # of Days < 32°F	45	44	15	89	17	72
Spring # of Days < 32°F (March-May)	9	9	5	24	1	23
Fall # of Days < 32°F (September-November)	7	7	4	20	1	19
Last Spring Frost Date (32°F)	6-Apr	7-Apr	17	5-May	25-Feb	71
First Fall Frost Date (32°F)	1-Nov	1-Nov	13	8-Dec	1-Oct	68
Frost-Free Period (Fall minus Spring)	207	207	25	269	154	115
Winter Precipitation (November-March)	26.30	26.08	5.50	37.38	12.44	24.94
Growing Season Precipitation (Apr-Oct)	15.12	15.02	2.78	21.53	8.12	13.41
Bloom Period Precipitation (May15-June15)	2.18	2.24	1.06	5.44	0.46	4.98
Ripening Period Precipitation (Aug15-Oct15)	4.40	4.15	1.97	8.99	0.52	8.47



**Figure 1** – Trends in the length of the median frost-free period (32°F) for 1948-2004 averaged over the Puget Sound AVA (Jones, 2005). Data Source: (Easterling et al., 2006).



**Figure 2** – Trends in growing season average, maximum, and minimum temperatures for 1948-2004 averaged over the Puget Sound AVA (Jones, 2005). Data Source: (Easterling et al., 2006).



**Figure 3** – Trends in growing degree-days (April-October) at a base temperature of 50°F for 1948-2004 averaged over the Puget Sound AVA (Jones, 2005). Data Source: (Easterling et al., 2006).